MARKHAM

Bird Friendly Guidelines

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Produced by:

North-South Environmental Inc.

Specialists in Sustainable Landscape Planning

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The City of Markham's emerging modern skyline, abundance of planned and protected green spaces and migratory bird paths contribute to increased bird injury and death. In response to the need to address Bird-Window Collisions, Markham Council has undertaken bird friendly retrofit projects to the Civic Centre Building, Fred Varley Art Gallery, Markham Museum and Thornhill Community Centre, as well as including bird friendly design in the Cornell Community Centre and South East Community Centre. Markham Council has provided further leadership in the preparation of Bird Friendly Guidelines as a City–wide tool to encourage site and building design in a manner that minimizes the risk of strikes/collisions to birds residing in and migrating through Markham. Councilor Valerie Burke, Ward One, has been instrumental in advocating for a Bird Friendly Markham and providing input into the study process.

Produced by:

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Specialists in Sustainable Landscape Planning

In collaboration with:

FLAP

Landplan

MARKHAM

WALLMAN ARCHITECTS

EXECUTIVE SUMMARY

Bird strikes on human structures are estimated to be the second largest cause of avian mortality in Canada, exceeded only by cats. Estimates of annual mortality rates range in the USA alone range from 100 million to 1 billion. Volunteers for the Fatal Light Awareness Program (FLAP) Canada have documented approximately 45,000 Bird-Window Collisions (BWCs) in the Greater Toronto Area (GTA) since record keeping began in 2000.

Three groups of birds reside in Markham:

- Birds that reside year round in the municipality;
- Birds that breed in the municipality during the summer but fly south for the winter; and
- Birds that are migratory seasonal visitors.

By far, the highest number of collisions is related to small, forest-dwelling migratory songbirds. Birds are at risk of collision during the day as they seek food and shelter. Migratory songbirds have an additional risk as they migrate at night, and nighttime lighting interferes with their flight patterns. Almost all songbirds migrate at night, only stopping to rest and feed near dawn. Markham hosts a high density of migrants. They are spread throughout Markham and can be found within the Greenway System and in small dispersed patches of vegetation outside of the system. Fall migrating birds are by far the group most often involved in BWCs.

The remainder of collisions occur in April and May, indicating that spring migrants are also affected.

Most collisions occur during the day, on buildings with large areas of glass. Windows with adjacent vegetation that is reflected in the glass are most commonly associated with collisions. It appears that birds are attracted to reflected vegetation because they mistake it for habitat in which they can rest and feed during migration stopovers.

City lighting has a complex relationship with BWCs. Though migrating birds usually (in good weather) fly at heights over the height of even the tallest buildings in the GTA, light may attract them to find places to rest within cities during stopovers. They may descend if there is bad weather, particularly if visibility is poor. In this case, they may become confused by city lights, flying blindly into all kinds of structures.

Markham is implementing the Province of Ontario's and the Regional Municipality of York's requirements to intensify for future growth. The New Official Plan (2013) introduces a proposed urban structure which focuses intensification in nodes and corridors. Intensification may result in the development of more tall glass buildings with a resulting increase in night lighting. This document provides guidance in mitigating the risk of BWCs and thereby protecting migrating birds.

The Bird Friendly Guidelines are composed of Primary and Secondary Treatments which have been developed as a result of the best management practices review of specific sources such as FLAP Canada, the American Bird Conservancy (ABC) and other guidelines produced by governmental and non-governmental agencies. The most effective documented solution to prevent BWCs is to make the glass visible to birds, by reducing reflection and transparency. It would be ideal to apply treatments to all glass areas, however, in order to accommodate user needs a clear view through the glass can be permitted in some circumstances. The acceptance of treatments to improve visibility of the glass has been shown to be enhanced through leaving "gaps" that provide views. The cities of Toronto and San Francisco have found that an effective compromise is to leave 10-15% of the glass untreated. It is proposed that in the City of Markham, 15% of the glass may be left untreated, as long as it is less than $2m^2$ of contiguous glass area. In this regard the following recommendations have been proposed:

- Apply primary treatments on the building facade from finished grade to 16m to approximately 85% of the untreated window surfaces with the exception of glass windows smaller than $2m^2$ in area.
- Primary treatments for new buildings and site plan design may include applying external semi-transparent stripes, dots or other patterns.
- Primary treatments for retrofit of buildings may include blinds, shades and netting.
- For the 15% that is left without primary treatment, a secondary treatment is recommended for all areas greater than $2m^2$. The 15% is usually situated within the first floor of the building i.e. commercial and retail spaces.
- Secondary treatment may include closely-spaced window mullions, internal blinds and shades, ultraviolet patterns with greater than 20-40% reflectivity, tinting and angling of glass, and judicious placement of vegetation so that it does not reflect in the glass.
- Exterior lighting should be mitigated by shielding, so that light projects downward rather than skyward.
- Interior light should be mitigated by shutting lights out from 11:00 p.m. to 6:00 a.m.

The recommendations to implement the Bird Friendly Guidelines are as follows:

- That the Bird Friendly Guidelines be endorsed by Council and be made available to all residents, landowners, developers and planning and urban design professionals.
- That City staff incorporate bird friendly treatments in the City's Site Plan Approval process through preparation of a Bird Friendly Specifications Checklist to guide the treatments.
- That the City recommend a voluntary monitoring program to applicants during the Site Plan Approval process, if needed.
- That the City continue to be proactive in retrofitting municipal buildings with bird friendly treatments in order to reduce BWCs where appropriate and budgets permit.
- That City staff develop Bird Friendly Guidelines education and outreach program information for residential homeowners and the development community and explore the development of a lights out program for Markham.

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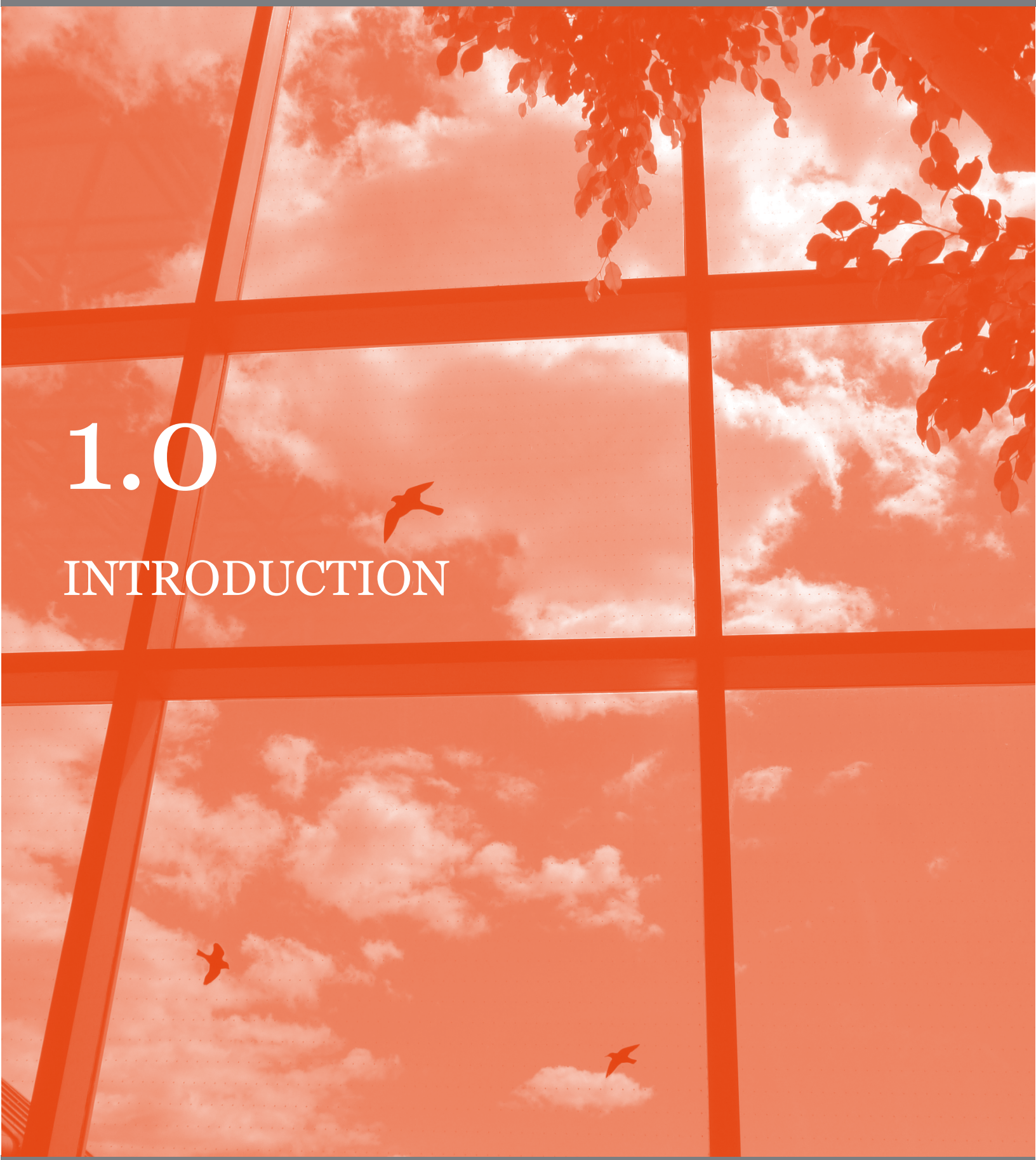


1.0

INTRODUCTION

1.0 INTRODUCTION AND POLICY FRAMEWORK

Bird strikes on buildings (including residential, low-rise and high-rise) are the second largest cause of avian mortality in Canada, exceeded only by cats (Calvert *et al*. 2013). With respect to bird strikes on buildings, the highest mortality per building is associated with high-rise buildings (Machtans *et al*. 2013). Estimates of annual mortality rates associated with buildings in the USA alone range from 100 million to 1 billion (Klem 2004; Hager *et al*. 2013), and in Canada range from 16 million to 42 million (Machtans *et al*. 2013).

The Fatal Light Awareness Program (FLAP) Canada is a non-profit organization that addresses the issue of Bird-Window Collisions (BWCs). Since 1993, volunteers have been active in picking up injured or dead birds near areas of frequent BWCs in the Toronto region. About 60% of the birds recovered by FLAP Canada are found dead (these are used for educational and research purposes). Over 80% of the injured birds rescued by FLAP Canada volunteers are rehabilitated and released back into the wild. FLAP Canada is also active in developing policy and monitoring legislation concerning BWCs (FLAP 2013).

Volunteers for FLAP Canada have documented approximately 45,000 BWCs in the Greater Toronto Area (GTA) since record keeping began in 2000. Of these, 899 have been documented in Markham. However, there are fewer volunteers monitoring in Markham and therefore the number of undocumented collisions is suspected to be much higher (Mesure 2013 pers. comm.).

Ovenbird
Photo by Tim Lenz/Creative Commons

Three types of birds reside in Markham: birds that reside year round in the municipality; birds that breed in the municipality during summer but fly south for the winter; and birds that are seasonal visitors.

Migratory birds are at greater risk of injury or death as they occur in very large numbers, and are not familiar with the urban environments that they fly through or settle in to rest and feed.

The majority of avian deaths are a result of impacts with transparent and reflective glass panels or panes; as birds are unable to detect glass, either during the day or at night.

Birds are at risk of collision during the day as they seek food and shelter. Migratory songbirds have an additional risk as they migrate at night, and night time lighting interferes with their flight patterns and may attract them into hazardous areas near buildings.

Findings of a recent study (Gelb & Delaretaz 2009; Hager *et al*. 2013) found that the following were the most important causes for bird strikes:

- A combination of nearby open space, vegetation and large windows (greater than $2m^2$), amount of glass and light is more predictive of deaths than building height;
- The frequency of collisions is higher along facades that are near extensive exterior vegetation and have either large reflective or transparent windows; and,
- The majority of documented collisions involved migrant species and occurred during the daytime.

At present, Markham has a number of high-reflective glass buildings distributed primarily within business corridors.

With the adoption of the City of Markham's New Official Plan (2013) and the objective to meet the Province's Places to Grow (2005) targets, the future Markham development structure presents new risks of BWCs with the increase of well-lit urban areas and the potential increase of glass buildings within employment and mixed-use neighbourhood areas (as per Official Plan designations).

Building owners have a responsibility under the *Ontario Environmental Protection Act*, and federal *Species at Risk Act* to undertake reasonable measures to protect birds from harm. A recent decision by an Ontario court emphasized that light emitted from buildings causes harm to birds; (refer to **Appendix A** - Applicable Legislation). Moreover, reflected light has the potential to injure Species at Risk that are protected by the federal *Species at Risk Act* or *Ontario's Endangered Species Act*. Taking action to address collisions is considered "due diligence".

Several major municipalities and agencies have taken steps to reduce BWCs, including Toronto, Chicago, New York City, San Francisco, Portland, Calgary and United States Green Building Council (USGBC). Recommendations from Toronto, Chicago, American Bird Conservancy (ABC), New York Audubon, and USGBC are widely adopted by regulation agencies across North America. Refer to **Appendix B -** Best Practices Summary.

Implications for Markham

The City of Markham has been active in creating bird friendly buildings through several initiatives such as the retrofitting of several existing municipal buildings (8100 Warden Avenue, Fred Varley Art Gallery, and Markham Civic Centre), incorporating bird friendly design standards in new municipal buildings (Cornell Community Centre and the future South-East Community Centre in eastern Markham); and encouraging new development to include existing bird friendly treatments such as the City of Toronto Bird-Friendly Development Guidelines through the Site Plan Approval process (*Planning Act,* Section 41). Refer to **Appendix C -** Markham Retrofit Projects.

1.1 Policy Context

Markham Council has endorsed the preparation of Markham's Bird Friendly Guidelines based in part on two other Markham policy documents: Greenprint, Markham's Community Sustainability Plan (2011) and the City of Markham's New Official Plan (2013).

Greenprint, Markham's Community Sustainability Plan (2011)

The Greenprint, Markham's Community Sustainability Plan (2011), is a long-term plan to address environmental health, economic vitality, social and cultural well-being. The Greenprint is a comprehensive strategy to make Markham one of the most livable and sustainable communities in North America. Within the plan are 12 integrated sustainability priorities that reflect Markham's unique context.

The Bird Friendly Guidelines support the Ecosystem Integrity priority with objectives to develop and support wildlife habitat and to increase biodiversity. Recommendations from the priority have been integrated into the Bird Friendly Guidelines including: adopt Bird Friendly Guidelines for all new and existing buildings; establish a dark sky policy; and work with local partners and the community to establish wildlife stewardship and education programs.

City of Markham's New Official Plan (2013)

The City of Markham's New Official Plan (2013) includes policies that promote the principles of sustainable community development. New growth will be concentrated in centres and corridors in the urban area with emphasis on compact higher density development. The Official Plan contains policies to protect and enhance key natural heritage features and their functions, both within the local context and in the context of the Province, as well as, significant features such as the Oak Ridges Moraine and the Rouge National Urban Park.

The urban design policies in the New Official Plan provide direction for the development of Bird Friendly Guidelines under section 6.2.2.7 to reduce occurrence of bird collisions with buildings for use as part of the development approval process. Section 6.2.3.1 of the Sustainable Buildings and Site Design section also states that it is the policy of Council to apply innovative sustainable design practices and technologies in site planning and building design through the development approval process. The list of sustainable design practices includes requirements for the use of window applications, shades and visual markers to reduce the risk of bird collisions with building facades; and minimizing the impact of lighting from development on the nocturnal environment and night sky. These policies have been considered in the development of the guidelines.

Photo by North-South Environmental Inc.

1.2 Purpose of Report

The Bird Friendly Guidelines study includes a review of background conditions relating to documented bird strikes in Markham, bird migration implications and the development of technical specifications which provides guidance on the types of treatments and techniques that should be implemented in site design, building design and the retrofit of buildings. The study also provides an implementation strategy on actions that the municipality could employ and manage to reduce BWCs. Relevant internal and external stakeholders including landowners, Ontario Association of Architects (OAA), Building Owners and Managers Association (BOMA), Building Industry and Land Development Association (BILD), and the Markham Developers Round Table were provided an opportunity to input into the study. The guidelines will act as a resource to the development industry and planning and urban design professionals and will inform the design of new buildings and also the retrofit of public and private urban spaces and built form.

2.0

BIRDS IN MARKHAM

2.0 BIRDS IN MARKHAM

Birds in Markham consist of:

- Those that generally move through Markham on migration on their way to breeding grounds further north, which may stop to rest and feed on the way (migrant birds);
- Those that live all year round in Markham (resident birds); and,
- Those that breed in Markham but migrate south in the winter (breeding birds).

The following provides a brief description of habitat use of each of those groups and explains why each group may be vulnerable to collisions with glass. **Appendix D** provides an existing conditions summary on BWCs in the GTA and Markham, and **Appendix E** provides a brief description of how to identify the "top 10" birds that are involved in collisions in Markham.

2.1 Migrant Birds

As can be seen in the radar image of migrating birds in **Figure 2-1**, migrants depart staging areas in high densities and move north around the Great Lakes, staying close to the north edge of Lake Erie, along the Niagara Peninsula and the north shore of Lake Ontario in very large numbers. They move north along the north shore of Lake Ontario in a dense band which is densest within approximately 1km of the lake shore (as shown by the colour purple and dark red) but is still very dense (shown by lighter red) as it passes through Markham. Birds appear to become more dispersed as they move north of Markham, as is shown by the yellow colour band.

Select groups of birds, such as hawks, falcons, waterfowl, swallows and nightjars, migrate during the day while most songbirds migrate at night. **Table 2-1** shows the top 10 species involved in collisions in Markham.

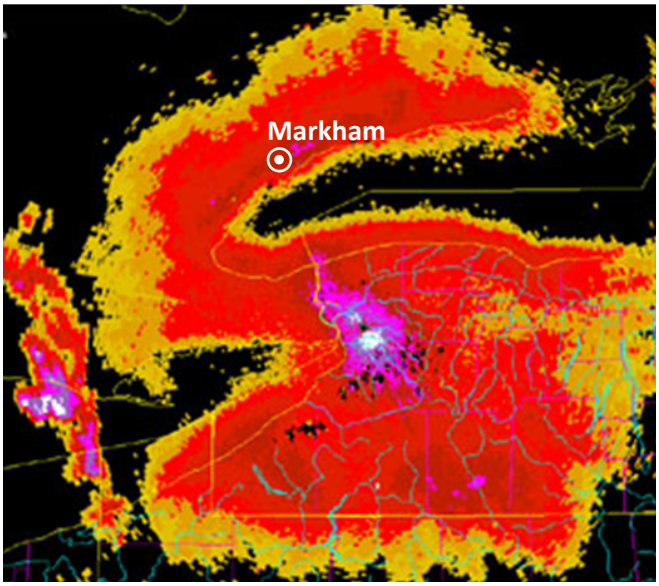


***Figure 2-1**: Radar image of night migration route around Lake Ontario*
Photo adapted from NEXRAD by FLAP Canada

Bird	Number of BWCs	Status
Nashville Warbler	97	Migrant
Golden-crowned Kinglet	82	Migrant
White-throated Sparrow	69	Migrant
Ruby-throated Hummingbird	55	Migrant and Breeding
Ruby-crowned Kinglet	52	Migrant
Dark-eyed Junco	50	Migrant
Yellow-bellied Sapsucker	29	Migrant
Black-capped Chickadee	23	Resident
Mourning Dove	21	Resident and Migrant
Ovenbird	21	Migrant

***Table 2-1:** Bird-Window Collisions recorded in Markham from 2000-2012 by FLAP Canada*

Birds are vulnerable to collisions with buildings not because they hit them during flight, (as they migrate well above the height of buildings), but because they drop out of migration before dawn to rest and feed. As shown in **Figure 2-2**, migrants have been observed stopping to rest and feed in many locations around Markham. There are few reports of areas where songbirds consistently stop in large numbers; rather, they seem to spread out and use a wide variety of habitats.

Nocturnal migrants tend to depart staging areas at dusk. Their departure is governed by a combination of weather factors, but generally birds prefer to migrate in good weather with southerly winds as they move north and with northerly winds as they move south. In good weather, birds may fly through the night until they land before dawn, and then feed at first light. In bad weather, or at times when birds' fat stores are depleted (for example in unusually cold weather or strong winds) birds may make an emergency stop well before dawn, landing wherever they can. These emergency stops are unpredictable. They often result from a combination of circumstances such as adverse winds, rain and fog where visibility is poor.

2.2 Resident Birds

Resident birds are those that reside in Markham year-round. These consist of species that do not migrate, with the most common including Northern Cardinal, Black-capped Chickadee, American Crow, Blue Jay, Downy and Hairy Woodpecker, Mourning Dove and American Goldfinch. These species do not appear to be commonly involved in BWCs in the GTA, though the resident Mourning Dove and Black-capped Chickadee are two of the top 10 in Markham with regard to collisions. However, even these resident species are mainly involved in BWCs during the migration periods (spring and fall). It is known that some Mourning Doves migrate, though some are residents, and that young Black-capped Chickadees move around extensively in the fall as they search for winter habitat, so it is likely that the BWCs involving these species also reflect birds that do not stay in the area for long periods.

2.3 Breeding Birds

Breeding birds are those that nest and raise their young to fledge in Markham. Locations of habitat-sensitive breeding birds surveyed by the Toronto & Region Conservation Authority (TRCA) are shown in **Figure 2-3**. Adults and young then fly south in the fall. Again, these species are less likely to be involved in collisions in Markham than are migrant birds, though Ruby-throated Hummingbirds, some of which breed in Markham while others fly through Markham on their way north to breed, are one of the top 10 species involved in collisions.

2.4 Markham's Greenway System

Threading through both the urban and rural landscapes of Markham are several major river valleys: the Rouge and the Don being the largest, as well as the smaller Petticoat and Duffins Creek in the east. Each river and creek is surrounded by varying widths of riparian vegetation that provides habitat for migrating, resident and breeding birds. Tributaries of each of these rivers also thread through the urban and rural fabric of the City. **Figure 2-2** provides an aerial photo view of the City overlaid with the Greenway System that protects, enhances and connects the significant natural heritage of the City. Breeding birds are well-documented within the Greenway System (**Figure 2-3**). They probably also breed in smaller patches of habitat outside the Greenway System; bird surveys shown in the figure (conducted by the TRCA) included mainly public property. Other areas may not necessarily receive the same level of effort. There is evidence that many migrants are found throughout the City in smaller patches of vegetation outside the Greenway System, so breeding birds would inhabit these areas as well.

***Figure 2-2**: Markham's Greenway System in relationship to areas where migrants have been observed and BWCs*
Photo by North-South Environmental Inc.

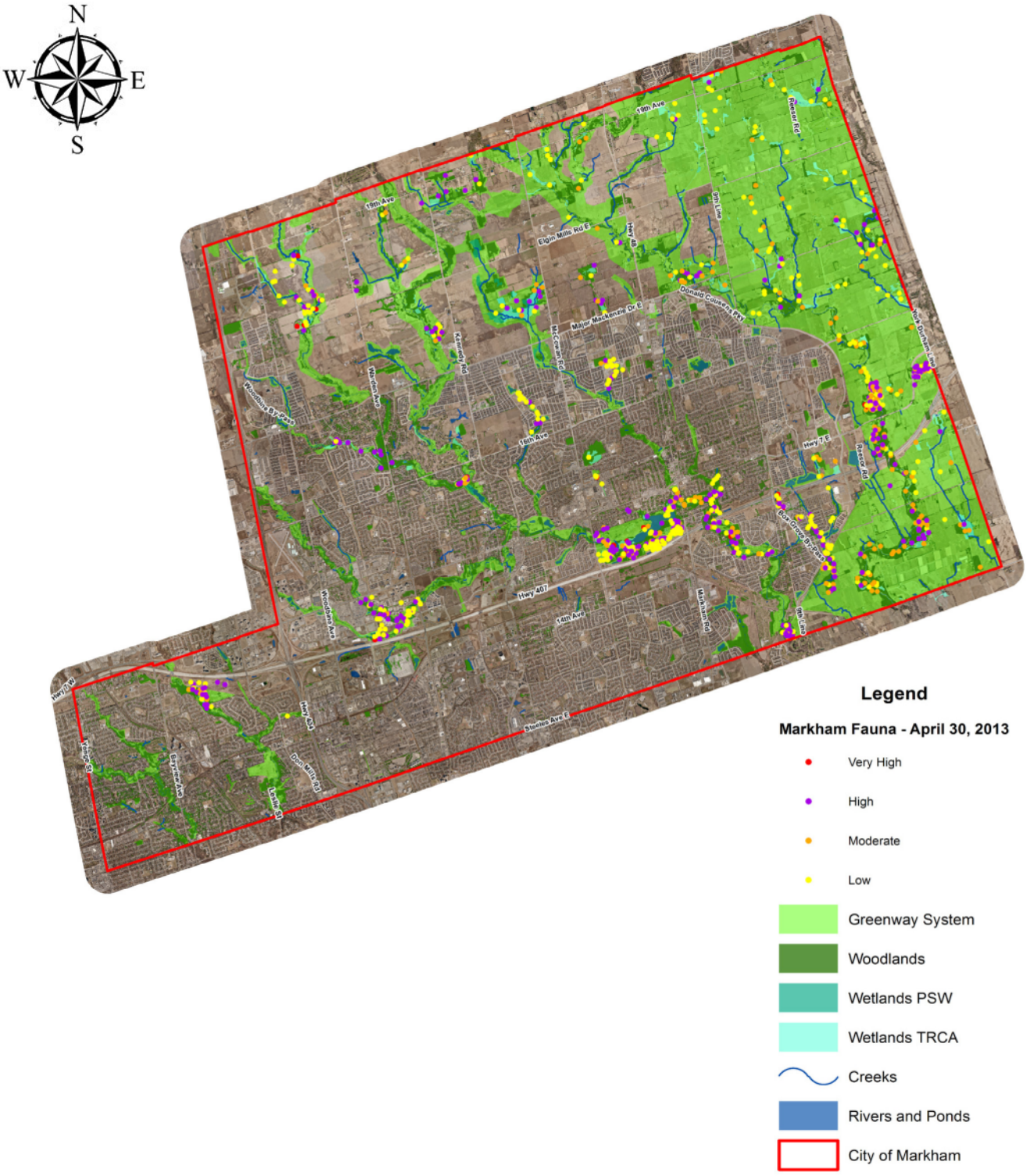


***Figure 2-3**: Markham's Greenway System and locations of breeding birds classified according to their susceptibility to BWCs*
Photo by North-South Environmental Inc.

3.0
BIRD-WINDOW COLLISIONS

3.0 BIRD-WINDOW COLLISIONS

This section describes what is currently known about BWCs in Markham, drawing on FLAP Canada's documentation. It elaborates on the primary causes of BWCs based on documentation in other parts of the GTA and North America, as well as specific observations in Markham.

3.1 Bird-Window Collisions in Markham

Approximately 900 BWCs were recorded in Markham between 2000 and 2012 (FLAP Canada 2013), though the number is suspected to be higher as less effort is spent in Markham than in other parts of the GTA (Mesure 2013 pers. comm.). BWCs were concentrated in areas shown in **Figure 2-2**. The distribution shown on **Figure 2-2** indicates that BWCs are not localized near natural areas in Markham, but tend to occur in areas where glass buildings are concentrated.

Most BWCs in Markham occurred during the day (Mesure 2013 pers. comm.). Forty-seven percent of documented collisions occurred in September, and 35% occurred in October, indicating that, as in the rest of the GTA, fall migrating birds are by far the most often involved in BWCs. Three percent of collisions occurred in April, and 10% occurred in May, showing that spring migrants are also affected. Collisions during all other months make up less than 1% of the total number, indicating that resident and breeding birds are less often involved in BWCs. However, it is known that there are undocumented collisions, for example those related to bird feeders outside residential windows.

Dr. Daniel Klem Jr. (2013 pers. comm.), who has researched BWCs for decades, noted that any building could attract BWCs if it had large amounts of glass facing areas of vegetation, even if that vegetation consisted of manicured trees and shrubs. This is borne out by the areas in which BWCs are observed outside the Greenway System.

3.2 Markham Development Structure

Markham has been mandated by the Province to intensify for future growth. The New Official Plan introduces a proposed urban structure which focuses intensification in nodes and corridors. Intensification may result in the development of more tall glass buildings with a resulting increase in night lighting.

Planted trees near windows are an amenity of urban life
Photo by North-South Environmental Inc.

Glass buildings are a feature of modern cities
Photo by North-South Environmental Inc.

3.3 Factors: Glass and Other Reflective Surfaces

Reflectivity

Surfaces that reflect habitat are seen as habitat by birds, which fly into them. Reflective surfaces can include glass, polished marble (especially dark colours as it is more reflective), or polished stainless steel. Birds may fly into glass that reflects vegetation, sky or water. Birds may even attack their own reflection in reflective surfaces.

Birds may fly into glass that reflects vegetation
Photo by North-South Environmental Inc.

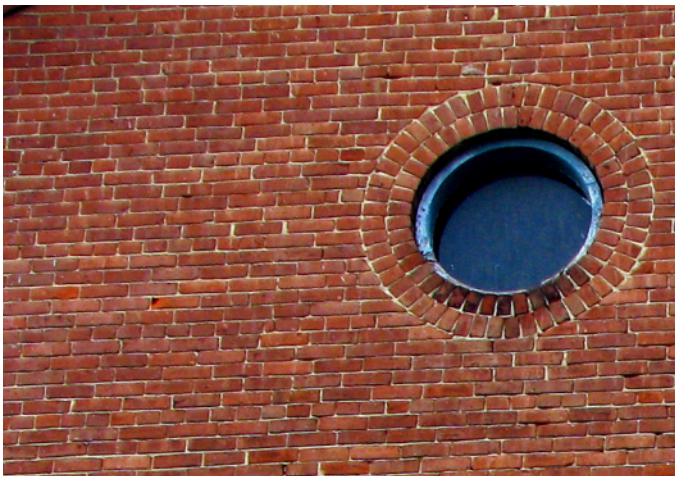
Transparency

Both research and anecdotal evidence indicate that birds do not see glass as a barrier (Klem 2013 pers. comm; Mesure 2013 pers. comm.). A bird that sees habitat through glass may fly into the glass as if it were not there. Habitat can include trees, flowers, water, sky etc. Birds may fly into glass if they can see what they perceive as habitat inside the glass (e.g. house plants), or if they can see habitat on the other side of the glass (for example vegetation, sky or water through link ways, courtyards, bus shelters, plexiglass barriers on verandas, etc.).

Birds that see habitat through the glass may fly into the glass

Black Hole/Passage Effect

Birds may fly into what they perceive as a “gap” in an obstacle. For example a dark, reflective spot in an otherwise impermeable building may appear to be a way through the building. The size of the bird is an important determinant of the size of the glass that may be a problem: e.g. hummingbirds may collide with smaller perceived passages (Mesure 2013 pers. comm.).



Birds may fly into what they perceive as a gap in an obstacle
Photo by dok1/Creative Commons

Building largely composed of glass

Glass reflects elements perceived as habitat such as sky, vegetation or water

Size of a building is not necessarily associated with numbers of collisions

Overall Design

The highest numbers of BWCs in Markham are associated with buildings that are largely composed of glass (Mesure 2013 pers. comm.). However, the "threshold" percentage of glass associated with collisions is poorly understood, since most monitoring has been conducted at "high collision" areas, and these are usually at glass buildings. However, it is known that under certain circumstances, even small areas of glass can cause problems. Research has not been conducted to show what types of buildings are consistently free of collisions.

Types of Glass

Almost any type of glass can be associated with BWCs. If the glass is transparent, it can be perceived as leading to habitat. If it is reflective, it generally reflects elements perceived as habitat such as sky, vegetation or water.

Building Size

The size of a building is not necessarily associated with numbers of collisions; except in the case where the amount of glass is proportionally high in relation to the size of the building. The surface area of glass is one of the most important factors in predicting the number of BWCs. The larger the glass surface, the higher the BWCs (Hager *et al*. 2013).

Orientation

Though each façade of a building tends to have a unique "signature" when it comes to BWCs, there is little information on the effect of orientation. For example, there is no evidence that south-facing facades are more likely to have BWCs than north-facing facades.

Proximity to Natural Features

The proximity of development and the relationship to the surrounding landscape (along with the area of glass) has been noted as one of the most important factors associated with BWCs. The closer the glass building is to natural features, generally the higher the BWCs except in some circumstances where vegetation is in very close proximity (see below). There are fewer collisions in areas with a high percentage of buildings and pavement. Hager *et al.* (2013) found that BWCs were affected by proportion of development in the immediate vicinity of a building (i.e. within 50m), as well as by the surface area of glass. There are two reasons for this: birds are attracted to natural habitat to rest and feed during migration and thus if the vegetation is closer to the building, birds have a higher probability of colliding with the building. Second, the larger the area of vegetation, the more birds are likely to be attracted to it. However, some buildings have high numbers of BWCs even though they are not immediately adjacent to large areas of natural habitat. The birds may be just as attracted by lush landscaping.

Siting

Siting of the building is very important, mainly because the building's relationship to the surrounding vegetation is so important. Building siting can deter potential BWCs to some extent. For example, it is noted that buildings sited in areas where there is a higher concentration of development (i.e. buildings and other impervious surfaces) are less likely to be involved in BWCs. This is probably because birds are more attracted to areas that appear to contain suitable habitat. However, birds tend to seek out smaller areas of habitat during migration, which can include landscaped gardens even in highly developed areas. If landscaped gardens are reflected in the glass, this may be more important than the siting of the building.

The following passage emphasizes the importance of window treatment in allowing flexibility in siting and landscaping:

- "A building that is designed to deter bird collisions will allow for most any type of site landscape design. Although the proximity and height of landscape material have been shown to influence the number of bird collisions, if the building facade is designed to be 'bird-friendly', the landscape material will not reflect and cause confusion to birds." – LEED Manual

Proximity of development and relationship to surrounding landscape is one of the most important factors associated with BWCs

Siting of the building in relation to surrounding vegetation is very important

Birds are attracted to vegetation in courtyards

Generally collisions occur from the ground to the top of reflected trees (16m)

Reflections on green roofs may only reach a few metres above the roof
Photo by Brian Roth

Design Traps

Enclosed features such as window-lined courtyards can “trap” birds, especially if the courtyard is highly vegetated, and/or contains a water feature (Mesure 2013 pers. comm.). Birds are attracted to the vegetation within the courtyard and then fly into the surrounding windows.

Reflected Vegetation

Bird-Window Collisions are most often associated with glass that reflects vegetation. The reflections can be associated with a natural feature, or can be associated with planted gardens. Both features seem to attract birds and are associated with BWCs. The height of the vegetation is the most important factor in dictating the height at which BWCs will occur. Generally, collisions occur from the ground to the top of the reflected trees (approximately 16m is considered to be the height to which urban trees usually grow). However, if a building is next to a slope, the height of the reflected vegetation may be greater than when the building is on flatter ground. Moreover, the height of mature trees in a natural area can reach 25m or more. In this case, BWCs will occur at higher levels of the building.

Green Roofs, Gardens and Walls

Green roofs adjacent to glass may attract birds and these birds may become involved in BWCs. As with vegetation on the ground, it is the height of the vegetation that dictates the height of BWCs. Vegetation on green roofs is generally adapted to shallow soils so is usually composed of grasses and herbaceous plants, possibly with a few shrubs. These generally do not reach the height that trees can reach, so reflections in the glass may potentially only reach few metres above the roof. However, some roof gardens have planted trees.

3.4 Factor: Lighting

Fatal Light Attraction

Migrating birds are attracted to artificial urban light at night under specific circumstances. The attraction is not well understood, as songbirds migrate well above cities at night, and may use brightly lit objects such as the moon and stars as navigational cues. Different colours may differ in their attractiveness to birds. Light may be particularly attractive to birds during bad weather when birds descend to rest until the weather improves and becomes more conducive to navigation.

Beacon Effect and Urban Glow

Birds attracted by urban lights that form a "cone" or beacon of light in fog may be reluctant to leave the light and fly into the darkness beyond. Under these circumstances they become disoriented and panicky, flying into anything that they cannot see clearly such as windows, tall communication towers, wires, and even structures that they would normally be able to see such as smokestacks, the ground and even each other. Some mortality events at tall buildings have involved extensive numbers of birds (Erickson *et al.* 2005).

3.5 Factor: Building Height and High Risk Bird-Window Collision Areas

The science of BWCs is evolving. While it used to be thought that night lighting was primarily responsible for collisions, it is now known that many collisions occur in the daytime within Markham (Mesure 2013 pers. comm.). There may be an interaction between night lighting and daytime bird collisions, which is poorly understood (Sheppard 2013 pers. comm.). Lighting may draw birds to seek habitat in cities where they are at risk of collisions. It is possible that the majority of nighttime bird collisions occur only in bad weather, where rain and fog cause birds to come down to the height of buildings (Gelb & Delacretaz 2009); and predicting locations and numbers of these collisions may be very difficult. Night collisions are much more prevalent in Toronto near the waterfront (Mesure 2013 pers. comm.). It is worth considering flight patterns of birds in relation to buildings of various heights, especially relative to night lighting within cities.

Migrating birds are attracted to artificial urban light

Nighttime Migration Path Threat

Songbirds generally migrate from approximately April to late May in spring, and September to late October in the fall. As shown by **Figure 3-1**, in good weather most songbirds migrate over the height of most buildings, but may rarely reach the height of the tallest in some cities. Over land, they usually fly at 640-730m (2,100 to 2,400 feet) but sometimes much lower (Cornell Laboratory of Ornithology 2007). Over water, migration takes place at a much higher altitude, from 1829-3658m (6,000 to 12,000 feet). Weather conditions often affect the migratory altitude as birds may fly higher or lower to avoid or take advantage of prevailing winds. **Figure 3-1** illustrates the height at which birds migrate in relation to buildings in the GTA.

What does this mean in relation to the height of buildings in the GTA, and in Markham in particular? The height of the CN Tower, the tallest free-standing structure in the GTA, is 553m. First Canadian Place in Toronto, the tallest building in Canada, is 298m (72 storeys). The tallest buildings in Markham generally range from 56m (18 storeys) to 31m (10 storeys). However, four buildings of over 20 storeys are under construction in Markham, two of which are 33 storeys, with several more planned for the near future (Emporis 2013a). Buildings that reach the height of migrating songbirds are rare in the world, and in North America. For example, One World Trade Centre in New York is the tallest building in North America and the fourth tallest building in the world (Emporis 2013b) but reaches only 541m (104 floors): below the height of the CN Tower. Even these buildings are below the height at which songbirds normally migrate. However, the degree to which birds are drawn down to lighted buildings at night in good weather is still unknown. What is known is that turning lights out on a building where high collisions have been documented can reduce the number of collisions dramatically (ABC 2011).

Seasonal Migratory Threat / Bad Weather Threat

The greatest potential threat to migratory songbirds from tall buildings is thought to occur in bad weather.

During bad weather, when navigational cues may be impeded by rain, low cloud and fog, birds descend to much lower heights, as needed, to improve visibility. In the most extreme conditions they stop wherever they can to rest until the weather improves. As noted above, they may be trapped by light and become disoriented, and are especially likely to collide with structures at this time. Bad weather does not appear to contribute to a greater likelihood of BWCs in resident or breeding birds.

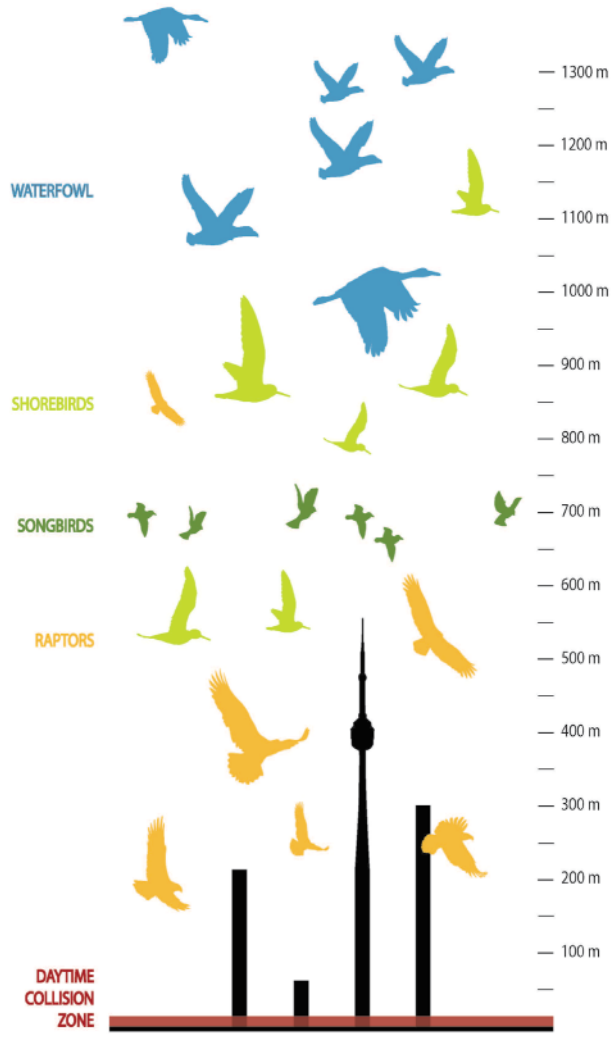
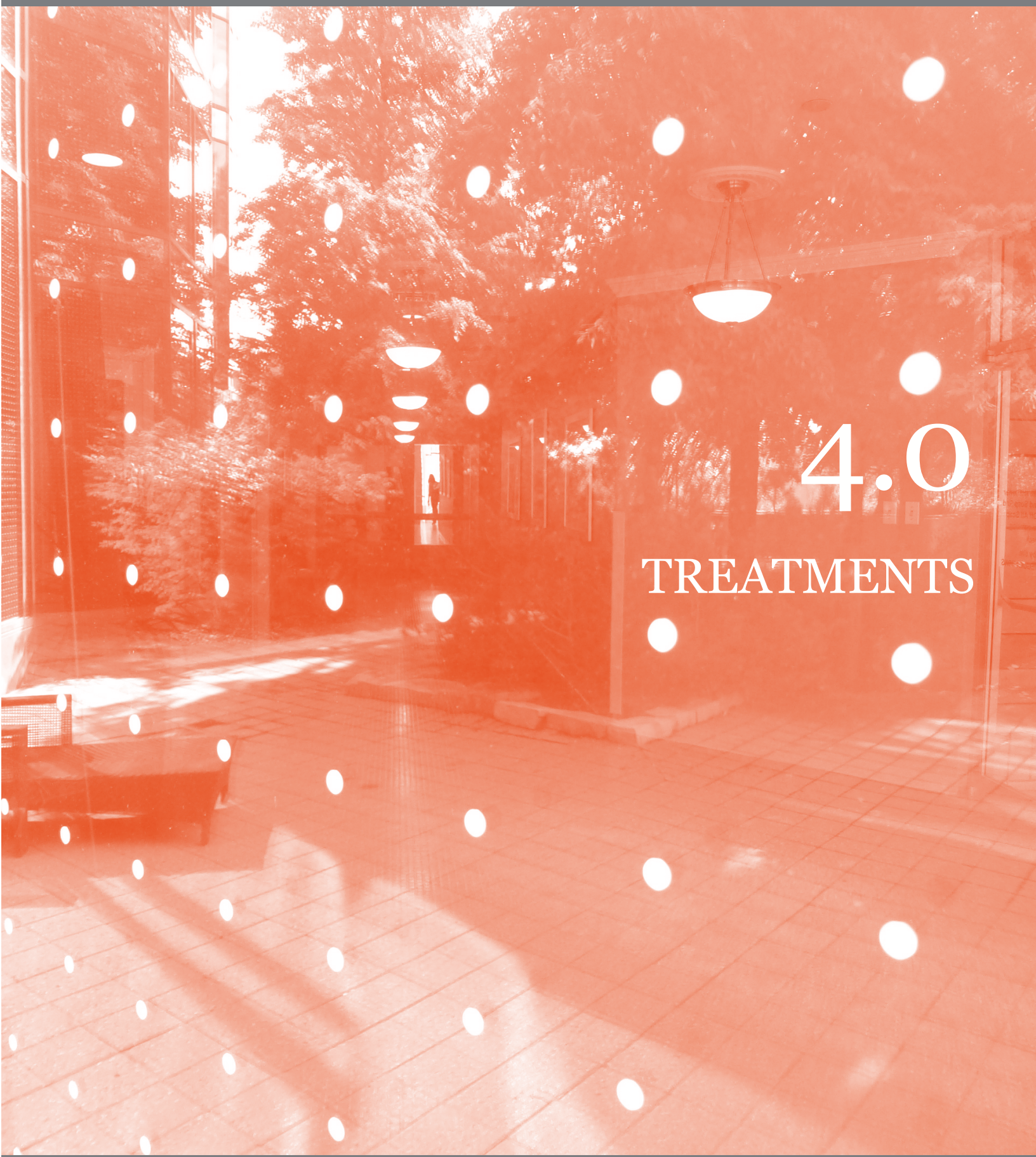


***Figure 3-1**: Approximate range of bird migration heights over land, in good conditions: adapted from figure in New York's Bird-Safe Guidelines*
Graphic adapted from New York's Bird-Safe Guidelines by North-South Environmental Inc.



4.0

TREATMENTS

4.0 TREATMENTS

Researchers studying BWCs have applied two different experimental techniques. The first technique includes the placement of glass panes in the edge of a field adjacent to successional deciduous forest and shrubs (e.g. Klem 2013). In this experiment, birds fly freely through the vegetation, striking panes which are not seen and avoiding panes that are visible to them. The number of collisions is then assessed, by comparing results for treated and untreated panes. The birds' behaviour when approaching the panes is also observed. The second technique is to release birds into a long room (such as a trailer) where light is provided only by windows at the far end. In this case the bird is given two options; one treated pane and one untreated pane. The birds must make the decision to fly at one or the other. The behaviour of the birds approaching the panes is then recorded. Information is also derived (though usually informally) from statistics gathered before and after treatment of buildings. Other studies have compared strikes on buildings with different areas of glass and amount of adjacent vegetation (e.g. Gelb & Delacretaz 2009; Hager *et al*. 2013). Through this research, it has been determined that the most effective documented treatment to prevent BWCs is to make the glass visible to birds, by reducing reflection and transparency. Specifications that have been developed are shown in empirical studies and by practical experience in the GTA to reduce numbers of bird strikes by at least 80%, as recommended by FLAP Canada.

4.1 Application of Treatments

The application of bird friendly treatments must accommodate user requirements, therefore a balanced approach has been established. It would be ideal to apply treatments to all glass areas, however, in order to accommodate user needs a clear view through the glass can be permitted in some circumstances. The acceptance of treatments to improve visibility of the glass has been shown to be enhanced through leaving "gaps" that provide views. The cities of Toronto and San Francisco have found that an effective compromise is to leave 10-15% of the glass untreated. It is proposed that in the City of Markham, 15% of the glass may be left untreated, as long as it is less than 2m^2 of contiguous glass area.

Treatments in the City of Markham Guidelines are founded on best management practices (also refer to **Appendix B -** Best Practices Summary) and research.

16m Zone of Protection

The recommendation to treat areas up to a height of 16m, which is applied in several jurisdictions including the City of Toronto and comes fr**o**m several recent findings:

- The buildings where the largest numbers of bird collisions occur are those that are next to the tallest vegetation; and,
- The average size of mature trees in the GTA is not 12m, but 16m.

The City of Toronto has recently changed its standards to reflect that the height of treatment for new City-owned buildings or major additions must be 16m (City of Toronto 2013). The City of Toronto is looking into changing its guidelines to reflect this in 3 years (Mesure 2013 pers. comm.).

In some circumstances, there is potential for vegetation to reflect in windows higher than 16m; for example, when a natural area adjacent to a building is on a slope. In this case, the height of the vegetation potentially reflected at approximately 91m from the building should be used to guide the height of the treatment. For example, if the height of vegetation reaches 20m at a distance of 90m, the façade would have to be treated up to 20m.

The primary treatment standard is based on a minimum standard for visual cues developed by Dr. Daniel Klem Jr. and incorporated into most of the published guidelines.

It states simply that to minimize bird collisions visual marker spacing on clear or reflective surfaces on a structure should not exceed 5cm (2 inches) on the horizontal plane or 10cm (4 inches) on the vertical plane. Refer to **Figure 4-1**.

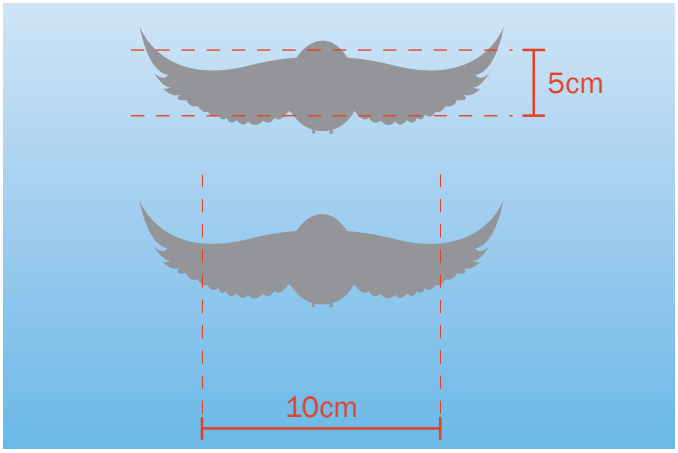


***Figure 4-1**: Minimum standard for visual cues/markers developed by Dr. Klem*

Primary treatments hold to this standard. Secondary treatments are those which allow some flexibility in window design, and have been shown to be somewhat effective in making glass more visible to birds, but do not meet the standard for primary treatments.

Figure 4-2 illustrates the circumstances under which primary and secondary treatments apply, and where no treatment is required. The diagram shows the area on a façade up to 16m in height as the area where reducing the potential for bird strikes must be considered. For 85% of glass area, primary treatment is required. Up to 15% of the glass can be left without primary treatment. However, it is recommended that a secondary treatment be applied to glass area larger than $2m^2$, as these represent the areas with the highest risk of BWCs.

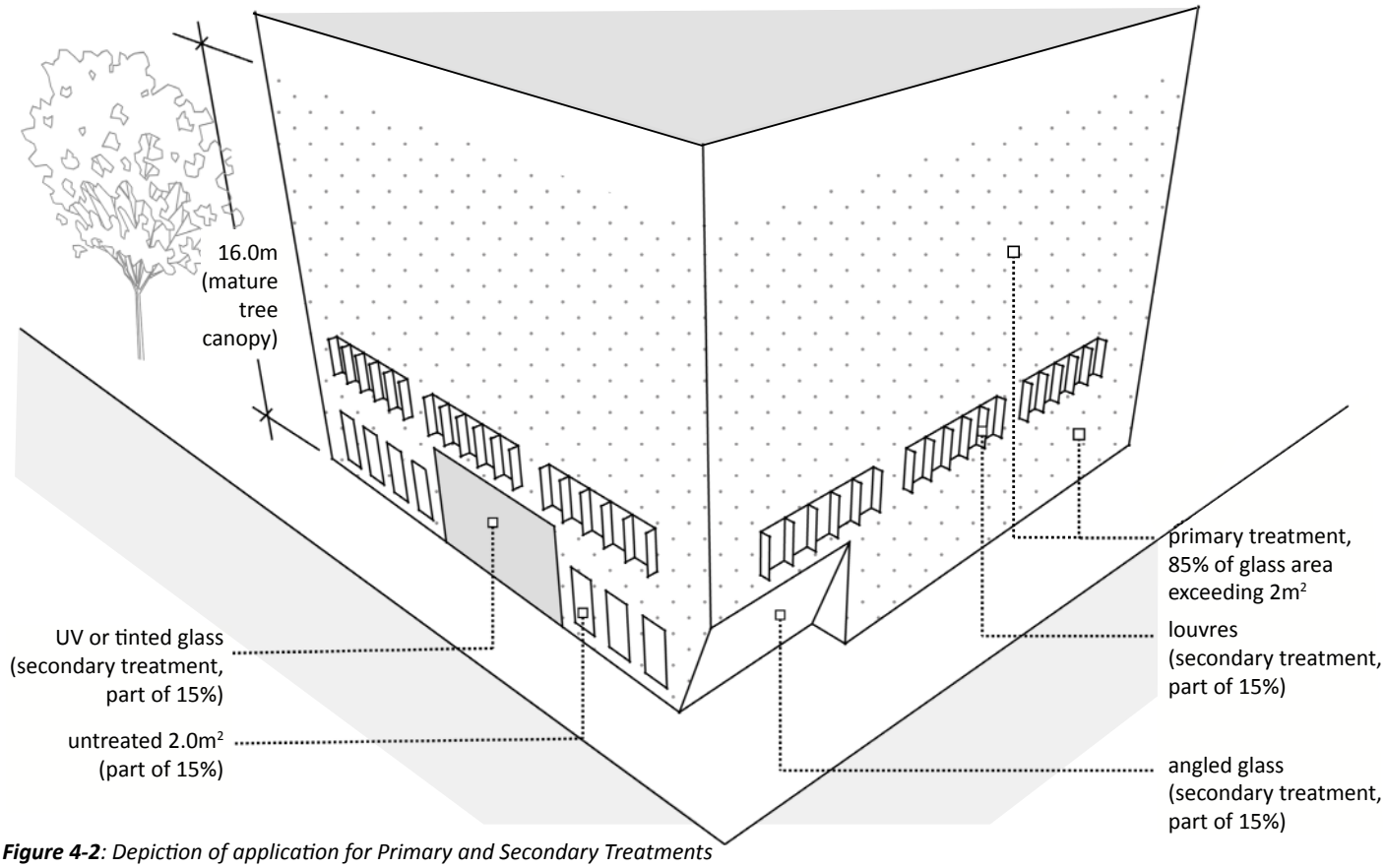

16.0m (mature tree canopy)
primary treatment, 85% of glass area exceeding 2m²
louvres (secondary treatment, part of 15%)
angled glass (secondary treatment, part of 15%)
UV or tinted glass (secondary treatment, part of 15%)
untreated 2.0m² (part of 15%)

***Figure 4-2**: Depiction of application for Primary and Secondary Treatments*
Graphic by Wallman Architects

2m² rule

There is evidence that buildings with smaller areas of glass and smaller windows are involved in fewer collisions than buildings with larger areas of glass and larger windows. One study found that in an urban landscape, windows of more than 2m² are more likely to be involved in collisions than windows of less than 2m² (Gelb & Delacratez 2009). Contiguous areas of glass no bigger than 2m² can be left untreated. The opportunities to apply secondary treatments to these areas are dependent on site conditions and can be discussed during the development approval process. Heritage buildings will not generally require treatment, as long as they are largely built of brick and other non-reflective and non-transparent materials, and have only small glass windows (generally less than 2m²). Additions with contiguous areas of glass that exceed 2m² should be subject to treatments similar to other glass buildings. It should be noted that BWCs can occur on smaller windows under certain circumstances.

15% rule

It is proposed that in the City of Markham, primary treatment is not required for 15% of the glass. Secondary treatments are preferred for areas without primary treatment; and there is some flexibility in the secondary treatment design. Within this 15%, areas of contiguous glass less than 2m² can be left untreated. The 15% would generally be applied primarily to retail window surfaces or building areas where the internal building function requires unimpeded views.

The application of secondary treatments to the remaining 15% is site specific and can be discussed during the development approval process. A cautious approach should be used with designing windows less than 2m² so that they do not create an illusion of a throughway to areas of habitat.

Certain configurations of glass are at very high risk to birds, especially glassed-in courtyards or atria adjacent to gardens and water features that attract birds. Glass that is highly transparent with vegetation on both sides can be especially lethal to birds. In these circumstances primary treatments should be applied.

Canopies, awnings and overhangs that create external building shade have been suggested as a viable treatment in some jurisdictions, as found within **Appendix B -** Best Practices Summary. According to FLAP Canada they have proven to be inefficient and therefore we have not included them as a treatment.

The treatment of windows to reduce the risk of Bird-Window Collisions may be a consideration taken by the development industry to obtain LEED credits. Refer to **Appendix B** for further information.

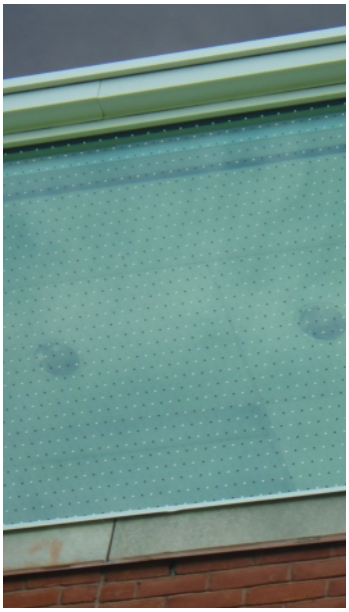
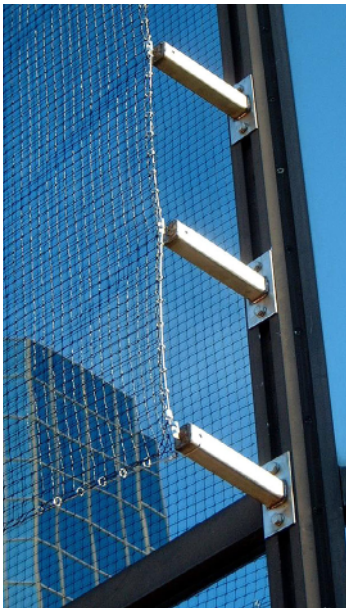
4.2 Primary Treatments

The following treatments shall be addressed as part of the Site Plan review process. Primary treatments would generally be applied on 85% of contiguous glass area greater than 2m² and within 16m from finished grade. The goal of these treatments is to reduce the risk of BWCs by approximately 80%, as recommended by FLAP Canada.

Primary treatments are those that adhere closely to the patterns that have proven to be most effective: a highly visible pattern that follows the rule of maximum 5cm untreated space on the horizontal plane and 10cm untreated space on the vertical plane.

Guidelines have been developed to assist in the implementation of each of the four treatments listed below:

1. **Integral/Applied Coverings – Stripes**
2. **Integral/Applied Coverings – Dots**
3. **Integral/Applied External Coverings – Netting**
4. **Frit and Etched Patterns**

Primary Treatment 1: Integral/Applied Coverings - Stripes

GUIDELINES

1. **Apply treatment on 85% of contiguous glass area greater than 2m^2 and within 16m from finished grade.**
2. **Treatment may be applied to both retrofit or new buildings.**
3. **Horizontal stripe treatment shall be at a maximum spacing of 5cm on centre.**
4. **Vertical stripe treatment shall be at a maximum spacing of 10cm on centre.**
5. **Stripe should be at a minimum 6.1mm width for vertical and a minimum 3.1mm width for horizontal.**
6. **Treatment should be applied to outer surface. Treatments applied to inner surfaces do not decrease glass reflectivity.**

NOTES

- According to American Bird Conservancy, applied coverings/adhesive films can significantly reduce the threat of BWCs.
- Vertical or horizontal that cross at different angles (as shown below) can provide considerable latitude for interesting designs.
- Treatment should be considered in the context of the internal building function. Stripes and other patterns should be contrasting enough to be visible to birds
- At the Earth Rangers Centre for Sustainable Technology (LEED gold certified) in the GTA, decorative window film has been applied to achieved a LEED Innovation credit.
- Where views are imperative (such as at-grade commercial or retail uses), the 15% rule may be applied.

Photo by North-South Environmental Inc.

Photo by FLAP Canada

Primary Treatment 2: Integral/Applied Coverings - Dots

GUIDELINES

1. **Apply treatment on 85% of contiguous glass area greater than 2m^2 and within 16m from finished grade.**
2. **Treatment may be applied to both retrofit or new buildings.**
3. **Dot size shall be minimum 5mm.**
4. **Dot colour shall be of high contrast in relation to the background.**
5. **Dot spacing shall be maximum 5cm on centre.**
6. **Treatment should be applied to outer surface. Treatments applied to inner surfaces do not decrease glass reflectivity.**

NOTES

- Dots appear to be less effective than stripes (Mesure 2013 pers. comm.) but may be more acceptable to building users. Application should be considered in the context of the internal building function.
- Designs such as squares, triangles, etc. may be used.
- Insulation value of materials used for patterns should be considered.
- Where views are imperative (such as at-grade commercial or retail uses), the 15% rule may be applied.

Photo by North-South Environmental Inc.

Photo by North-South Environmental Inc.

Primary Treatment 3: Integral/Applied External Coverings - Netting

GUIDELINES

1. **Apply treatment on 85% of contiguous glass area greater than 2m² and within 16m from finished grade.**
2. **Treatment may be applied to retrofit conditions.**

NOTES

- There is a potential for birds to become trapped behind the netting.
- Where views are imperative (such as at-grade commercial or retail uses), the 15% rule may be applied.
- Netting should be placed a few centimetres distance from the glass so that birds that fly into the netting do not hit the glass - the distance will vary depending on the netting material used.

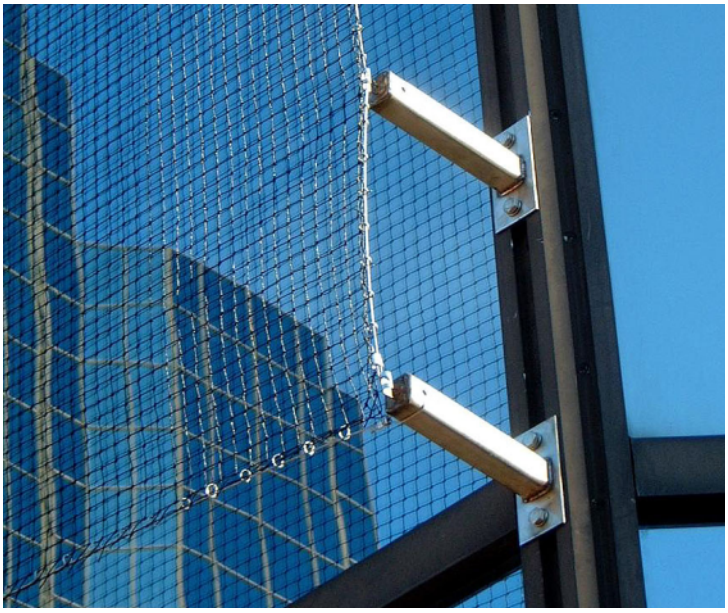


Photo by FLAP Canada

Primary Treatment 4: Frit or Etched Patterns

GUIDELINES

1. **Apply treatment on 85% of contiguous glass area greater than 2m^2 and within 16m from finished grade.**
2. **Apply treatment to new buildings.**
3. **Treatment should be applied to outer surface. Treatments applied to inner surfaces do not decrease glass reflectivity.**
4. **Treatment colour should be in colour of high contrast (depending on the background, this could be light or dark).**

NOTES

- Frit patterns prevent birds from seeing reflective glass as open sky or inviting habitat.
- Glass areas can sometimes change colour due to lighting. White can be less successful as a bird deterrent due to lighting change during different times of the day (ABC). However, white can be used in conjunction with other colours to produce a bi-coloured effect to increase effectiveness.

Photo by North-South Environmental Inc.

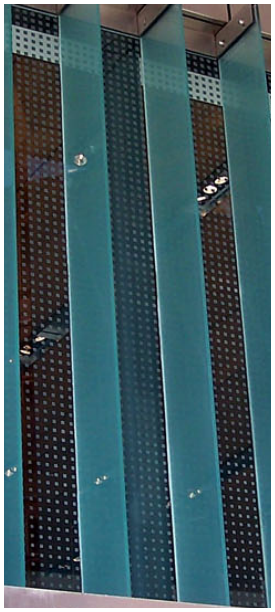
Photo by FLAP Canada

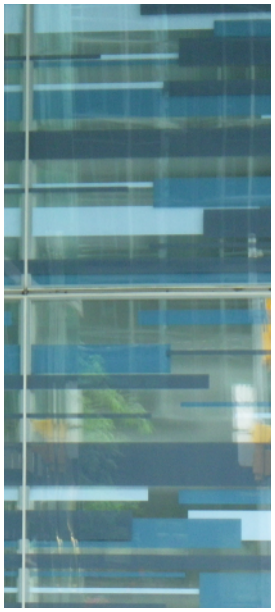
4.3 SECONDARY TREATMENTS

The following secondary treatments should be addressed as part of the Site Plan review process. It is recommended to apply secondary treatments on 15% of contiguous glass area greater than 2m^2 and within 16m from finished grade, and where views are imperative (such as at-grade commercial or retail uses), on areas without primary treatment.

Guidelines have been drafted to assist in the implementation of each of the seven treatments listed below:

1. **Internal Blinds and Shades**
2. **Louvers and External Coverings**
3. **Closely-Spaced Mullions**
4. **Tinting**
5. **Angling**
6. **UV Patterned Glass (Experimental)**
7. **Landscape Design**





Secondary Treatment 1: Internal Blinds and Shades

GUIDELINES

1. **Apply treatment on 15% of contiguous glass area greater than 2m^2 and within 16m from finished grade (areas without primary treatment).**
2. **Treatment may be applied in new and retrofit glass installations.**
3. **Treatment maybe applied to retrofit or new building design.**
4. **Horizontal blinds should have a maximum spacing of 5cm and a minimum thickness of 3.1mm.**
5. **Vertical blinds should have a maximum spacing of 10cm with a minimum thickness of 6.1mm.**
6. **Solid blinds should utilize contrasting colours.**

NOTES

- Blinds should be designed to provide as much contrast to glass as possible.
- White solid blinds generally provide lower level of contrast and may have high reflectivity depending on glass colour and lighting during different times of the day and therefore are not recommended.
- The application and effectiveness of interior blinds are dependent on building management.
- The opening and closing of blinds should be managed during bird migration periods.

Photo by North-South Environmental Inc.

Secondary Treatment 2: Louvers and External Coverings

GUIDELINES

1. **Apply treatment on 15% of contiguous glass area greater than 2m^2 and within 16m from finished grade (areas without primary treatment).**
2. **Treatment may be applied in new and retrofit glass installations.**
3. **Apply treatment to building exteriors.**
4. **Treatment should be opaque.**

NOTES

- Louvers that have the flexibility to be closed during migration periods are preferred.
- Louvers can contribute to control solar gain in interior space and have a sustainability value.
- Louvers could be designed as integrated component of building facades.
- Louvers can be in the form of screens, scrims, wire mesh, and exterior venetian blinds.
- External coverings can be in the form of roll up solar screens made of translucent polyester woven fabrics.

Photo by FLAP Canada

Secondary Treatment 3: Closely-Spaced Mullions

GUIDELINES

1. **Apply treatment on 15% of contiguous glass area greater than 2m² and within 16m from finished grade (areas without primary treatment).**
2. **Treatment may be applied in new and retrofit glass installations.**
3. **Mullions are most effective where tightly spaced and strongly contrasting. Width of mullions should be minimum 2.5cm to be effective.**

NOTES

- Mullions are generally applied to single family residential buildings and townhomes.
- Muntin bars can be incorporated to increase effectiveness.

Photo by North-South Environmental Inc.

Secondary Treatment 4: Tinting

GUIDELINES

1. **Apply treatment on 15% of contiguous glass area greater than 2m^2 and within 16m from finished grade (areas without primary treatment).**
2. **Treatment may be applied in new and retrofit glass installations.**
3. **Tinting should consist of a strong contrasting pattern.**
4. **Tinted glass should be non-reflective.**

NOTES

- Highly reflective tints should be avoided.
- Tinting colours can be varied to increase contrast.

Photo by North-South Environmental Inc.

Tinting showing a strong contrasting pattern
Photo by North-South Environmental Inc.

Secondary Treatment 5: Angling

GUIDELINES

1. **Apply treatment on 15% of contiguous glass area greater than 2m^2 and within 16m from finished grade (areas without primary treatment).**
2. **Treatment may be applied to new and retrofit building design.**
3. **Angle glass downward 20 to 40 degrees from the vertical plane.**
4. **Angling should only be considered in concert with other treatments to reduce reflection of vegetation on glass.**

NOTES

- Angled glass may reduce the force with which birds in horizontal flight strike panes. Although glass orientation does not eliminate BWC hazard (Klem 2004), it is an effective bird-strike deterrent.
- Angling is more practical in one storey structures or at ground level in multi-storey buildings.
- The effectiveness of angled glass may be limited as birds frequently fly at angles other than horizontal (ABC).
- In some instances, angling may not reduce the reflection of vegetation on glass surfaces.

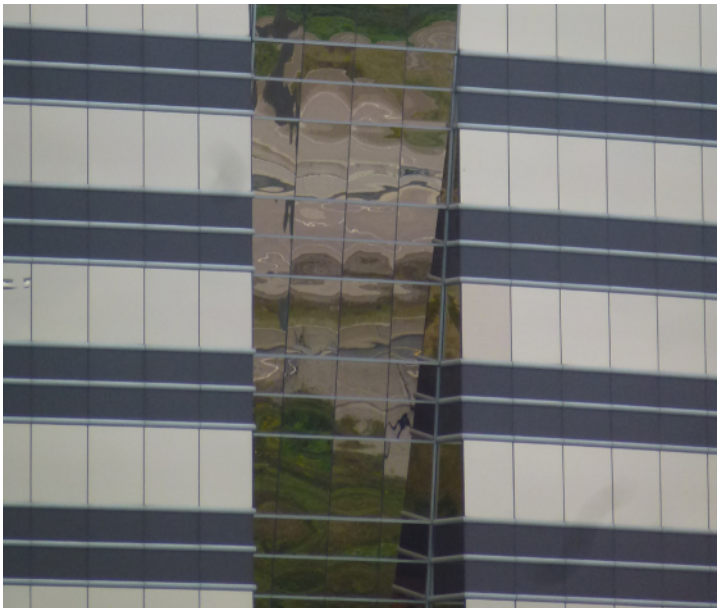


Photo by North-South Environmental Inc.

Secondary Treatment 6: UV Patterned Glass (Experimental)

GUIDELINES

1. **Apply treatment on 15% of contiguous glass area greater than 2m² and within 16m from finished grade (areas without primary treatment).**
2. **Pattern should be at maximum 5cm horizontal spacing and 10cm vertical spacing.**
3. **Ultraviolet reflectivity needs to exceed 20-40% and be adjacent to contrasting areas of UV-absorption (lower or higher) to be visible.**

NOTES

- Birds can see further into the ultraviolet spectrum than humans.
- Treatment is still in experimental stage.
- Results of experiments are promising in some cases but are inconsistent.
- If effective, UV patterned glass would be ideal for areas where views are imperative (such as at-grade commercial or retail uses).

What birds see
Photo by Arnold Glas

What humans see
Photo by Aliza Baltz

Secondary Treatment 7: Landscape Design

GUIDELINES

1. **Generally, locate trees and vegetation within 3m from glass areas or further than 30m from glass areas.**
2. **Buildings fronting on public sidewalks should apply other bird friendly treatments to glass areas.**
3. **Minimize the use of vegetation that bears fruit and attracts birds adjacent to highly reflective glass.**
4. **Interior greenery should be located well away from windows.**
5. **Cluster a higher numbers of trees away from non-treated surfaces.**
6. **Place low shrubs and groundcovers adjacent to highly reflective glass.**
7. **Avoid planting trees where they reflect clearly in untreated glass.**

NOTES

- "A building that is designed to deter bird collisions will allow for most any type of site landscape design. Although the proximity and height of landscape material have shown to influence the number of bird collisions, if the building facade is designed to be 'bird-friendly', the landscape material will not reflect and cause confusion to birds." – LEED Manual
- It has been reported that it can also be effective to plant vegetation immediately adjacent to the facade so that birds cannot build up momentum before they hit the facade; however, BWCs have still been documented to occur (though less frequently) under these circumstances (Mesure 2013). A strategy of placing opaque design features between vegetation and glass to break up reflection could also be considered where circumstances permit.

Photo by The Landplan Collaborative Ltd.

4.4 Lighting Treatments

These recommendations are included in order to attempt to reduce the presence of artificial city lights which are attractive to migrating birds.

While daytime collisions are thought to be more frequent than nighttime collisions in Markham, it is likely that city lighting plays a role in attracting birds to the downtown areas where the greatest risk of collision occurs, or that it may play a role in confusing birds.

Guidelines have been developed to assist in the implementation of the treatments listed below:

1. Mitigate Interior and Exterior Lighting

Interior lighting plays a negative role in attracting birds to buildings

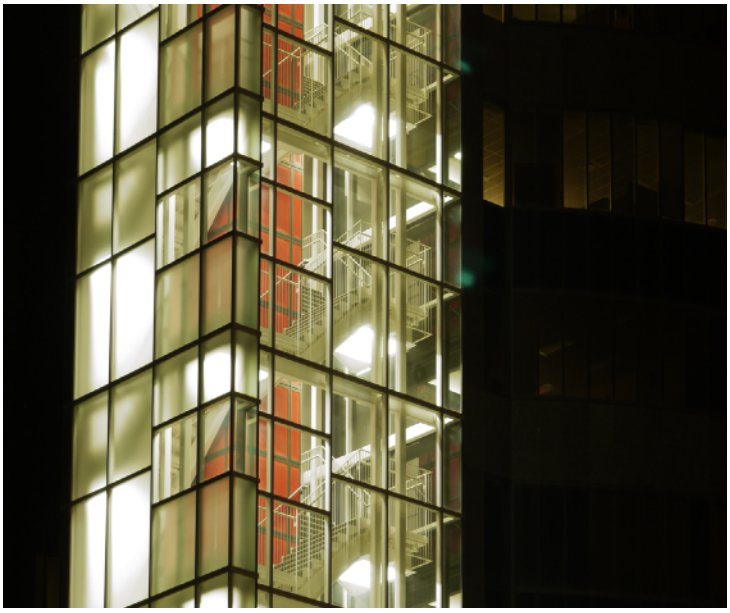
Lighting Treatment 1: Mitigate Interior and Exterior Lighting

GUIDELINES

1. **Eliminate up-lighting by attaching cut-off shield for streetlights and external building lights.**
2. **Limit lighting to areas where lighting is needed for safety and security. There should be no light spill outside the property line.**
3. **Require lights out from 11 p.m. to 6 a.m. or minimal light use during spring (March-June) and fall (August-October) bird migration periods.**
4. **Provide motion sensors or auto shutoff system with maximum 30 minute vacant period.**
5. **Avoid creating "pools" of light that could attract birds especially during inclement weather.**

NOTES

- Hundreds of bird species migrate at night. On clear, moonlit nights, they will often fly at high altitudes and, consequently, avoid possible obstructions. But artificial lights from human civilization can confuse them, especially on foggy, rainy nights or when cloud cover is low. White and red lights appear to be more disorienting and attractive to birds than blue and green light. Birds may fly toward lit structures such as skyscrapers and lighthouses. Even spotlights can "entrap" birds. They fly into the beams of light, unwilling to fly out again. Exhausted, they fall to the ground. Many birds that collide with lit structures are killed outright. Those that are injured or exhausted become easy prey to scavengers like raccoons (FLAP 2013).
- LEED Pilot Credit 55 Bird Collision Deterrence requires both interior and exterior lighting strategies that reduce light trespass. This can include manual and automated shutoff for lights, and shielding that prevents light from spilling into areas where it could attract birds.



Unnecessary interior lighting within an underutilized stairwell

Photo by North-South Environmental Inc.

5.0

IMPLEMENTATION

5.0 IMPLEMENTATION & RECOMMENDATIONS

Bird friendly design practices should become part of the building culture for developers and residents within Markham. Buildings can be made safer for birds through a combination of primary and secondary treatments for new and existing buildings, and use of lighting practices that are designed to reduce the attractiveness of buildings to migratory birds. The combination of all practices is recommended to reduce the cumulative hazard to birds that depend on Markham as a migration route, rest stop, foraging ground, winter refuge and nesting area.

Appropriate implementation mechanisms for Bird Friendly Guidelines should be integrated with City practices and protocols. A comprehensive approach is recommended which includes not only the application of window treatments but other measures to reduce Bird-Window Collisions in Markham. The following section provides recommendations that the City may consider in the implementation of bird friendly treatments.

5.1 Endorse Bird Friendly Guidelines

It is recommended that the Bird Friendly Guidelines be adopted by Council and be made available to all residents, landowners, developers, planning and urban design professionals.

The Bird Friendly Guidelines should be treated as a living document and updated to reflect new best management practices research and technology. The focus of the update would be Section 4: Treatments and Section 5: Implementation and Recommendations, though new advances in research would be incorporated into other sections as underpinnings for any revised recommendations. It is recommended that the document be reviewed every five years, though new research that provides new insights into the problem of Bird-Window Collisions should be incorporated sooner. For example, the use of ultraviolet treated glass, which can be seen by birds but not by humans, should continue to be investigated to determine if it can be made more consistently effective.

5.2 Site Plan Approval Process

Section 41 of the *Planning Act* provides for the consideration of matters relating to exterior design of buildings through Site Plan Approval, including the character, scale, appearance and design features of buildings and their sustainable design. Markham's New Official Plan contains policies requiring the application of sustainable design practices in site planning and building design, including window applications to reduce Bird-Window Collisions, and minimizing the impact of building lighting on the night sky. In order to effectively utilize this authority, it is recommended that the Site Plan Approval process be revised to update the Pre-Consultation and Site Plan Approval application documents to include a Bird Friendly Specifications Checklist that will be used by municipal staff to guide applicants on Bird Friendly implementation requirements.

5.3 Voluntary Monitoring Program

Monitoring is highly recommended, specifically where glass facades are proposed and particularly if the proposed bird friendly treatments/measures are selected based on site design or on secondary window treatments where permitted by the Bird Friendly Guidelines, and for untreated windows less than $2m^2$. Staff may recommend a Voluntary Monitoring Program to be included as part of the Site Plan Approval process administered by a third party at the time of development to ensure that appropriate bird friendly treatments are implemented and inspected. The collection of information before and after the treatment of buildings is extremely important in order to refine and enhance future treatments for buildings in Markham. It should be understood that the guidelines are designed to reduce collisions, but that it is impossible to eliminate all possibility of collisions. The likelihood of collisions at any one window is a result of a combination of factors that can be extremely site-specific, such that collisions may not always be predictable. There are financial implications to any monitoring program and the applicant will need to determine how best to address these matters as they move forward to implement the strategy.

5.4 Retrofit and Audit of Existing Buildings

These guidelines are produced to address the application of Bird Friendly Guidelines for new buildings subject to Site Plan Control. However, given the due diligence aspect arising from recent legal decision regarding direct harm to birds, it is recommended that commercial, retail, residential and municipal buildings be retrofitted wherever possible and feasible. FLAP Canada has developed a Bird Safe Building Standard and Audit which can be used in determining potential building impacts of BWCs and determine high to low risk priority sites. Homeowners, building owners and municipal staff can use this auditing tool to determine high risk buildings and plan appropriately for priority retrofit projects. FLAP Canada Bird Safe Building Standard and Audit can be used to identify high risk buildings and determine priority sites. Contact FLAP @ flap.org for more information.

If opportunities arise to explore partnerships with universities, FLAP Canada, Environment Canada or other research institutions, a monitoring study should be considered in order to further the understanding of approaches to treatment.

5.5 Education and Outreach/Lights Out Program

Education and outreach is an important component of Markham's bird friendly initiatives. Window treatments should become a familiar part of window design through treatment of appropriate windows on all buildings. Public acceptance of bird friendly patterns on glass may be increased by making window treatments a familiar part of building design.

It is recommended that bird friendly communication materials be prepared to guide the development industry and residents on bird friendly implementation matters. For instance, a Lights Out Program similar to the City of Toronto's education and awareness program on bird protection and energy conservation could be considered. For the development community, an education brochure can encourage the need for retrofit of buildings and provide information on available treatments. The understanding of the reasons behind BWCs should be clearly laid out so that developers can design more sensitively to avoid situations that create a higher risk for collisions.

For residential homeowners, an education brochure can describe to the homeowners the impacts glazed and reflective windows have on birds and explore the benefits of the window treatments. Residents can also be encouraged to cover their own windows and turn off unneeded lights. Residents could be given the incentive to monitor birds near their windows. If collisions occur, they should be provided advice on measures that can be used to reduce numbers of collisions such as treating windows, relocating bird feeders and modifying vegetation, if necessary, in order to reduce small scale impacts.

GLOSSARY

GLOSSARY

Building Industry and Land Development Association (BILD): was formed through the merger of the Greater Toronto Home Builders' Association (GTHBA) and the Urban Development Institute/Ontario. BILD is the voice of the land development, home building and professional renovation industry in the Greater GTA. BILD represents more than 1,400 member companies. Their membership includes: home builders; land developers; professional RenoMarkTM renovators; land use and environmental planners; sub-contractors; manufacturers; lawyers; surveyors; architects; suppliers; and representatives of service, professional and financial institutions. For more information, visit http://www.bildgta.ca.

Bird-Window Collisions (BWCs)/Strike: any occurrence, whether fatal or not, of a bird colliding with a building which are most often associated with glass that reflects vegetation. The reflections can be associated with a natural feature, or can be associated with planted gardens.

Building Owners and Managers Association (BOMA): is the voice of the Canadian commercial real estate industry with over 3,200 members in regional associations across Canada. On behalf of the building owners, managers, developers, facilities managers, asset managers, leasing agents, brokers, and the product and service providers to over 2.1 billion square feet of commercial real estate in Canada, BOMA Canada addresses issues of national concern, and promotes excellence in the industry through information, education advocacy and recognition. BOMA has a local Toronto office, for more information, visit http://www.bomatoronto.org.

Contiguous Glass Areas: is defined as a continuous window construction, including frames or mullions, glazing units, and muntin bars, within a facade and separated in all directions by an opaque facade component. A contiguous glass area can be a glazing panel used for decorative or life-safety purposes and can include, but not be limited to, balcony guards, balcony dividers, louvers or projections made of glass installed in any position other than horizontal, guards, and balustrades. For the purposes of determining areas to be treated, it can also include spandrels: decorative glass that does not provide a window, and which reflects adjacent vegetation. It could also include areas of highly polished marble or stainless steel. For the purpose of these Guidelines, a maximum of 15% of the glass area on a façade can be left without treatment. The 15% would generally be applied primarily to retail window surfaces or building areas where the internal building function requires unimpeded views. Within this 15%, it is preferred that secondary treatments would generally be applied except on areas of contiguous glass less than $2m^2$.

Endangered Species: means a species that is listed or categorized as an "Endangered Species" on the Ontario Ministry of Natural Resources official Species At Risk in Ontario List, as updated and amended from time to time.

Fatal Light Attraction: the consequence of the increase in artificial lighting by streetlights and buildings, whereby nocturnal migratory bird species are attracted to and disoriented by our cities' glowing night skies. The effects of fatal light attraction are exacerbated in poor weather such as rain or fog.

Fatal Light Awareness Program Canada (FLAP): was founded in 1993 to spearhead international efforts to preserve migrating birds from collisions with buildings. This organization has been instrumental in promoting awareness of BWCs in Toronto, where their work is primarily focused, as well as in many other municipalities across Canada and the United States. FLAP Canada has consulted with many landowners, (public and private) to survey and monitor buildings where incidents of strikes have occurred and recommendations on new building construction and retrofitting existing development.

Frit Patterns: glass that is manufactured with a visible embedded pattern within the glass.

Fenestration: the arrangement of glass panels and/or windows in a wall.

Heritage Buildings: buildings that are listed on the Inventory of Heritage Properties for their historical and architectural significance.

LEED® Canada for New Construction and Major Renovations (2009): is the Canada Green Building Council's nationally accepted standard of sustainability for the commercial, residential, and institutional building industries. Credits are awarded in six categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation In Design and Regional Priority. For more information, visit http://www.cagbc.org.

Light Pollution: the unnaturally increased illumination and temporary fluctuations in lighting produced from man-made sources such as building lights, street lamps and vehicles.

Light Spill: a form of light pollution resulting from excess artificial light (i.e., lighting fixtures) from a focused source being cast where it is not useful or desired.

Light Trespass: a form of light pollution, where potentially unwanted light crosses a property line.

Migration: animal species' long distance movement from one habitat to another, according to the seasons and on an annual cycle.

Mullions: the bars between panes of glass in a window.

Natural Area: means features and areas which are important for their environmental and social values as a legacy of the natural landscapes of an area.

Opaque Facade Component: defined as a solid facade construction that is neither reflective nor transparent. Examples can include, but not be limited to, masonry, precast concrete, metal panel, EIFS, or wood facade and rainscreen constructions; spandrel panels with an infill panel of a material other than glass, back-painted or otherwise; or a screen, scrim, or continuous louvers applied over glazing or other construction with openings or spaces no larger than 50mm in at least one direction.

Treatments: modifications to windows, window coverings, buildings and landscaping to reduce the potential for BWCs.

Public Building: a building that belongs to a town, city or regional office, and is used by the public.

Primary Treatment: is defined as a standard based on a minimum visual markers/cues. In order to minimize bird collisions visual marker spacing on clear or reflective surfaces on a structure should not exceed 5cm (2 inches) on the horizontal plane or 10cm (4 inches) on the vertical plane. Primary treatments for new buildings and site plan design may include applying external semitransparent stripes, dots or other patterns. Primary treatments for retrofit of buildings may include blinds, shades and netting.

Secondary Treatment: is defined as treatments which allow some flexibility in window design, and have been shown to be somewhat effective in making glass more visible to birds, but do not meet the standards for primary treatments. Secondary treatments may include closely-spaced window mullions, internal blinds and shades, ultraviolet patterns with greater than 20-40% reflectivity, tinting and angling of glass, and judicious placement of vegetation so that it does not reflect in the glass.

Spandrel Panel: the opaque portion of a building's exterior between the top of a window and the sill of the window above.

Up-lighting: light that is projected directly upward by inefficient lighting fixtures. Direct upward light contributes greatly to artificial sky glow.

Visual Markers/Cues: a term used to describe birds' visual perception created by solid/opaque surfaces or physical cues on the exterior of a building which help its surface appear different than reflected sky or habitat.

Visual Noise: the effect of the application of visual markers on the appearance of a building. A building with high visual noise will be more visually distinct from reflected habitat or sky, and more easily distinguished and avoided by birds.

Window-to-Wall Ratio (WWR): is defined as the area of fenestration, including frame or mullion and glazing, relative to the total area of the facade. Treatment is required on each facade, and as such, the WWR of each facade shall be evaluated independently. WWR = Area Glazing – including frames (m^2) / total façade area (m^2).

APPENDICES

APPENDIX A: APPLICABLE LEGISLATION

LEGISLATION CITED IN THE YONGE CORPORATE CENTRE CASE

A recent (February 2012) court case (Podolsky v. Cadillac Fairview Corp. 2013 ONCJ 65) has brought the issue of Bird-Window Collisions into prominence, and has pointed out that there is a legal requirement in Ontario to prevent Bird-Window Collisions. Three charges were brought against the owners of the Yonge Corporate Centre (YCC) in Toronto: specifically in regard to buildings where some of the highest BWCs in the GTA had been recorded. The three charges were under *Ontario's Environmental Protection Act* (EPA), the federal *Species at Risk Act* (SARA), and the Ontario *Society for the Prevention of Cruelty to Animals Act,* as follows:

> "During the period beginning on or about September 3, 2010 and ending on or about November 7, 2010 … did commit the offence of causing animals to be in distress by having or using highly reflective glass, including windows, that caused the death or injury of birds, contrary to subs. 11.2(1) of the *Ontario Society for the Prevention of Cruelty to Animals Act*, RSO 1990, c. O.36, as amended;
>
> During the period beginning on or about March 15, 2010 and ending on or about November 7, 2010 … did commit the offence of discharging or causing or permitting the discharge of a contaminant, namely radiation (light), from reflective glass, including windows, that caused or was likely to cause an adverse effect, namely death or injury to birds, contrary to subs. 14(1) of the *Environmental Protection Act*, RSO 1990, c. E.19, as amended;
>
> Between the 15th day of March 2010 to 7th day of November 2010 … did commit the offence of killing, harming, or taking individuals of a wildlife species, namely Canada Warblers or Olive-sided flycatchers, that are listed as a "threatened" species, by having or using highly reflective glass, including windows, contrary to the *Species at Risk Act*, s. 32(1). "

Legal Decisions

The following sections show the rationale cited behind the judge's decisions in the Yonge Corporate Centre case. The entire decision can be viewed here: http://www.ecojustice.ca/cases/migratory-birds-building-collision-ii-judgement-feb.-14-2013-1.

Ontario Society for the Prevention of Cruelty to Animals

This legislation was found not to apply to the case of migratory birds that were not held in captivity. The owners of the YCC were therefore acquitted of this charge. Specifically, the judge noted:

> "the Legislature's primary intendment in enacting the OSPCAA [was] the protection of pet, farm, display and performing animals (that is, domesticated and captive animals) and the maintenance of standards of care for their safety and well-being.
>
> For these reasons, and even accepting in arguendo that the defendants caused distress to the birds at issue, I do not believe their conduct is captured by the OSPCAA."

Environmental Protection Act

In this case, the judge found the defendants guilty of the act that harmed birds. He noted:

> "The evidence, both expert and circumstantial, called at this trial persuades me to the requisite standard that, in at least most cases of bird strikes at the YCC [Yonge Corporate Centre], the mechanism by which the collisions occurred was a result of the birds mistaking the reflecting surfaces of the buildings' windows and spandrels as extensions of the safe wooded havens from which they were flying at the time of impact.

> Whether or not actual or deemed or constructive knowledge of the impugned harm is essential to establish the actus reus [the "guilty act"] of a regulatory offence of this nature is of no moment in the present prosecution: the defendants, for at least a decade prior to the events at issue, knew that the reflective cladding of their buildings caused or substantially contributed to the death and injury of migrating birds."

He went on to note:

> "the YCC buildings "discharged" (by way "emission") a "contaminant" ("radiation" in the form of reflected light) into the "natural environment" that caused an "adverse effect" ("injury or damage", including, here, death, "to … animal life")."

This interpretation led the judge to the decision to find that the owners of the YCC had "permitted" the discharge of the contaminant. The "permitting" aspect of the offence centres on the defendant's passive lack of interference or, in other words, its failure to prevent an occurrence which it ought to have foreseen. Thus, the owners of the YCC were found guilty of this offence.

Species at Risk Act

Individual birds belonging to species scheduled as "threatened" under the *Species at Risk Act* (SARA) were among those many other birds "killed" between March 15 and November 7, 2010 as a result of collisions with the YCC buildings. The judge noted:

> "These deaths were undoubtedly unintentional. However, as I have earlier endeavoured to explain, even inadvertent or accidental deaths of members of a scheduled species fall properly within the physical definition of an offence under s. 32(1) of SARA."

The owners of the YCC were also found guilty of this offence. The *Species at Risk Act* generally applies only to (federally) listed species on federal lands. However, listed aquatic species and migratory birds protected under the *Migratory Birds Convention Act*, 1994 are protected wherever they are found.

Acquittal because of Due Diligence

The judge noted that despite the proof that the YCC had caused the harm, the accused could avoid liability by proving that they took reasonable care (so-called "due diligence"). Proof, in this context, would be satisfied on the civil standard, a balance of probabilities (i.e. not beyond reasonable doubt as in a criminal proceeding). If the defendants had not taken reasonable care to avoid harm to the birds, the defendants would necessarily be found guilty of the two offenses.

However the judge noted that:

> "the owners' investment in bird deterrent applications at the YCC appears to have accelerated in the period immediately following the company's first becoming aware that it faced prosecution for environmental and animal welfare offenses. Some may read this as a response to the litigation and infer that the defendants could earlier have acted with greater dispatch. I do not see it that way. As I construe the evidentiary record, the defendants had committed themselves to moving forward on the bird strike problem before, as one might say, the writ was dropped. The prior delays, on my assessment, were attributable to technological or logistic challenges presented by the YCC's physical setting and the development of a suitable product"

The judge found that the degree or level of harm or adverse effect must be reasonably balanced with economic considerations and the other factors set out earlier for a due diligence defence. He noted that the YCC apparently complied with municipal building and industry standards, that only a handful, at most, of buildings in the GTA had adopted a more aggressive strategy in deterring bird strikes by 2010, that the YCC implemented and maintained a policy to respond to nocturnal light pollution, that it had co-operated with FLAP Canada's bird retrieval, salvage and documentation efforts for more than a decade, and that it had endeavoured, if intermittently and without tangible success, to find solutions to the problem of daytime collisions since the late 1990s. The YCC had consulted with FLAP Canada about the problem of avian collisions and, on a few occasions, conducted test installations of window treatments that proved ineffective, unappealing to its tenants, or both. The presenting problems were complex and the necessarily site-specific solutions constantly evolving. The judge found that, even balanced against the number of bird deaths caused by the buildings, the due diligence defence applied to the case.

The judge found that though the prosecution had established the actus reus of two of the three offences charged, the defendants had demonstrated that, in all the circumstances, they acted with due diligence and had thus discharged their burden. He found the defendants not guilty of all charges.

Ontario Endangered Species Act, 2007

Ontario's Endangered Species Act, 2007 prohibits killing or harming of extirpated, endangered and threatened species, as follows:

> 9. (1) No person shall,
>
> (a) kill, harm, harass, capture or take a living member of a species that is listed on the Species at Risk in Ontario List as an extirpated, endangered or threatened species;

There is the potential for a building owner to be charged under this act if a provincially extirpated species, an endangered species or a threatened species is injured or killed through striking a window, or even potentially if it becomes trapped within some portion of a building. 70 individuals of 6 endangered and threatened species have been documented by FLAP Canada in window collisions in the GTA. There is the potential for any of these species to strike windows in Markham as well.

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[1] A species is classified as an extirpated species if it lives somewhere in the world, lived at one time in the wild in Ontario, but no longer lives in the wild in Ontario.

A species is classified as an endangered species if it lives in the wild in Ontario but is facing imminent extinction or extirpation.

A species is classified as a threatened species if it lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening to lead to its extinction or extirpation.

APPENDIX B: BEST PRACTICES SUMMARY

BEST PRACTICE IMPLEMENTATION STRATEGIES

Several major municipalities and agencies have taken steps to reduce Bird-Window Collisions, including Toronto, FLAP Canada, the American Bird Conservancy (ABC), Chicago, New York City, San Francisco, Portland, Calgary and United States Green Building Council (USGBC).

Standards from Toronto, Chicago, American Bird Conservancy, New York Audubon, and USGBC are widely adopted by regulation agencies across North America.

Toronto's mandatory bird friendly requirement and light out policies are based on known risk factors. New York City Audubon Society provides evidence of the success of implementation and identifies risk area in relationship with migration, weather, and time of the day. American Bird Conservancy presents mitigation measures in ranking of effectiveness backed by evidence. USGBC LEED developed Bird-Window Collision deterrence as a pilot credit that requires mitigation by building facade, exterior lighting, interior lighting and post construction monitoring program. San Francisco incorporates measurable mitigation standards into zoning ordinance. Chicago's strategies also improve urban design quality and sustainability. Calgary acknowledged risk areas in relationship to natural environment structure. Portland published its design guide in July 2012 based on best practise of bird friendly resources available to date.

Leadership in Environment and Energy Design (LEED) Pilot Credit

The Leadership in Environment and Energy Design (LEED) green building rating system is the preeminent program for the design, construction, and operation of high-performance green buildings worldwide. American Bird Conservancy, in cooperation with the USGBC, and the Bird-Safe Glass Foundation, have developed a LEED green building certification to earn credit for incorporating design strategies that reduce Bird-Window Collisions.

The strategies described in the LEED Bird Collision Deterrence Pilot Credit consider indoor and outdoor lighting design and operation, building façade design, performance monitoring, and threat factors. This means modifying glass reflectivity, color (including ultra violet), texture, or opacity. It should be noted that LEED would treat the whole of the façade whereas Markham is only considering the area of highest threat (i.e. the bottom 16m). Also, by enhancing window treatments to include energy efficiency, additional LEED credits could be obtained.

It is anticipated that proposed treatments in Section 4 could meet the performance criteria listed in the LEED Pilot Credit 5.5. The methodology to determine the scope of application of treatments would need to be evaluated.

WHAT ARE THE BEST PRACTICES?

FEDERAL

Government of Canada: protects migratory birds and nests.

US Congress (Proposed): Bird Friendly public buildings, adopted Toronto, Chicago, ABC, and New York Audubon standards.

REGIONAL

Province of Ontario: protects non-game birds, regulates the design of built environments, protects species at risk.

State of New York: Bird Friendly public buildings, adopted Toronto, Chicago, ABC, and New York Audubon standards.

State of Minnesota: Bird Friendly public buildings, public buildings mandatory light off during migratory period, and sustainability development standards for new and renovated buildings.

Cook County, Illinois: Bird Friendly new and major renovated buildings, energy conservation requirement.

MUNICIPAL

City of Toronto: Two tiers standards (mandatory tier 1 and optional tier 2), identify effective measures, public building evening and weekend light-out, tier acknowledgment program, and public campaign.

City of Calgary: Bird Friendly design and operation of public buildings and affordable housing, downtown BWCs analysis, site design criteria, and schedule cleaning during daytime.

City of San Francisco: zoning standards, maximum unbroken glazed area, and voluntary bird-strike hotline.

Non-Governmental Organizations

New York City Audubon: nighttime & inclement weather at-risk elevation level, nighttime migration path at-risk elevation level, minimize building footprint, and district wide light-out strategies.

American Bird Conservancy: windowed courtyards & open-topped atria as at-risk area, minimum treated glazing for lower and upper levels, evaluate effectiveness of mitigation measures, and rank light colours.

United States Green Building Council LEED: mandatory criteria comprise of building façade, interior & exterior lighting, and post construction monitoring program compliance, specify light angle, and light-off period.

FLAP Canada: recommendations for reductions in bird strikes on residential and office buildings include retrofits with patterns using the 5cm x 10cm rule, moving indoor vegetation so it is not visible through the glass, recommendations for treatment of the lower 16m of a building, and modifying lights to minimize exterior trespass.

BIRD FRIENDLY BEST PRACTICE REGULATIONS AND GUIDELINES: FEDERAL & REGIONAL EXAMPLES

	Government of Canada	Government of Canada	Province of Ontario	Province of Ontario	Province of Ontario
Regulations	**1994** ***Migratory Birds Convention Act***	**2002** ***Species at Risk Act***	**1997** ***Fish and Wildlife Conservation Act***	**1990** **Ontario *Planning Act* Section 41.7(a)5**	**2007** ***Endangered Species Act***
Adopted Guidelines	Not specified.	Not specified.	Not specified.	Not specified.	Not specified.
Scope of Regulations	Migratory birds: killed, captured, taken. Nests: damage, destroyed, removed, disturbed. Commercial transaction of migratory birds and nests.	Prevents killing, harassing, harming, capturing or taking of listed extirpated, threatened or endangered species on federal land; applies throughout Canada to listed species that are migratory birds.	Prohibit hunting or trapping of birds belonging to a species that is not designated a game bird.	Development that is subject to site plan applications: Municipality can require developer to provide facilities for the lighting, including floodlighting, of the land and of any buildings or structures thereon to the satisfactory and at no expense to the municipalities.	Prohibits harming, harassing and taking of Threatened and Endangered species; prevents or regulates habitat destruction.
Aligned Regulations	Not specified.	Not specified.	Not specified.	Not specified.	Not specified.

	US Congress (Proposed)	State of New York	State of Minnesota	Cook County Illinois (Includes Chicago)
Regulations	**Apr 2011** ***Federal Bird-Safe Buildings Act* of 2011 (Proposed)**	**Mar 2011** ***Bird-Friendly Buildings Act* 4204 & Bird-Friendly Building Council 4204A**	**2009** ***Bird-Safe Buildings Act*, Chapter 101, Article 2, Section 54 [16B2421]** **2010** **Sustainable Building 2030 Energy Standards (SB2030)**	**2008** **Adopted Bird Safe Building Ordinance**
Adopted Guidelines	Building Material defined by Chicago, Toronto, ABC and New York Audubon standards.	Recommendation includes Chicago, Toronto, ABC and New York Audubon standards.	Minnesota Bird-safe Building Guidelines, Audubon Minnesota Sustainable Building Guidelines Version 2.2 Update 2013.	Building Material defined by Chicago, Toronto, and New York Audubon standards.
Scope of Regulations	Public buildings only: construction, alteration, acquisition, interior & exterior lighting.	Public buildings only: construction, alteration, acquisition, interior & exterior lighting, reflective glass.	Public buildings only: turn off light from midnight to dawn during Mar 15 to May 31, and Aug 15 to Oct 31. For New Construction and Major Renovations with new or replacement glazing scope, all required criteria apply. These Include deterrent facades for areas that are bird attractants; reducing bird collision "traps"; monitoring of bird impacts during the building's first year; and incorporating Lights Out program concepts. For Major Renovations without new or replacement glazing scope, only "Lights Out" light management program is required.	All new construction and major renovation projects must incorporate bird-safe building materials and design features. Existing building where practicable.
Aligned Regulations	Not specified.	Not specified.	SB2030: new and substantially renovated buildings.	All buildings: minimum 8 points in the LEED Energy and Atmosphere category.

BIRD FRIENDLY BEST PRACTICE REGULATIONS AND GUIDELINES: SELECTED MUNICIPAL & AGENCIES EXAMPLES

	City of Toronto	City of Calgary
Regulations	**2010** **Green Development Tier 1 Requirement** for planning applications and inspection process**.** **2005** **Ontario *Planning Act* Section 41.7(a)5** Condition for exterior lighting.	**2008** **City of Calgary Sustainable Policy** For public buildings: new, renovated, affordable housing, operation.
Guidelines	**2007** **Bird-Friendly Development Guidelines.** **2009** **Bird-Friendly Development Rating System & Acknowledgment Program.**	**2011** **Bird-Friendly Design Guidelines.**
Scope of Regulations / Guidelines	All new buildings except residential low-rise.	Public buildings. All buildings and structures (voluntary).
Exemptions	Heritage designation permits up-lighting from exterior light fixtures. Up to 15% area allowed to be untreated "to be more realistic in terms of what is achievable for a variety of building types."	Not specified.

	USGBC LEED	City of San Francisco	American Bird Conservancy	New York City Audubon
Regulations	**Dec 2011** **Pilot Credit 55: Bird Collision Deterrence:** 1 building facade option, 1 interior lighting option, 1 exterior lighting option, and 1 post construction 3 years monitoring plan. **Added bird-friendly language to LEED guide.**	**Sep 2011** **Planning Code, Zoning Section 139: Standards for Bird-Safe Buildings.** **Section 101.1: Adopting environmental findings.** **Building Code Ch 13C: LEED and green building** For all new, renovation, alteration, addition commercial and residential buildings.	Not specified.	Not specified.
Guidelines	**Not specified.**	**2011** **Standards for Bird-Safe Buildings.** **2012** **Design Standards for Bird-Safe Buildings.**	**2011** **Bird-Friendly Building Design.**	**2007** **Bird-Safe Building Design Guide for New Construction and Renovation.**
Scope of Regulations / Guidelines	New construction, Existing buildings: operations & maintenance, core & shell, schools, retail, and healthcare.	New construction, building additions (replacement of 50% or more glazing), building features.	New, retrofit and existing buildings.	New, retrofit and existing buildings.
Exemptions	Building façade with a Threat Factor of 15 or below. Threat Factor is dependent on treated material type, treated area, and total façade area.	Residential buildings with height less than 14m and exposed façade less than 50% glazing. Waive by zoning examiner upon recommendation by a qualified biologist.	Not specified.	Not specified.

BIRD FRIENDLY BEST PRACTICE REGULATIONS AND GUIDELINES: SELECTED MUNICIPAL & AGENCIES EXAMPLES (CON`T)

	City of Toronto	City of Calgary
Hazardous site areas	Natural area, ravines, woodlot, or other natural feature.	400m from open space, river, valleys, natural parks. Within City Centre area.
Hazardous building area	0m-12m; Beginning in 2014, 16m for City buildings, 0m-mature tree height. 0m-12m above green roof. Supplementary buildings & on-site glass features.	0m-16m or 4 storeys. Abutting courtyard, green roof, habitat area. Building corners. Atriums, linkways, bridges.
Mitigation – elevation	Min 85% treated glazing required for first 12m (16m for City buildings beginning in 2014).	Not specified.

	USGBC LEED	City of San Francisco	American Bird Conservancy	New York City Audubon
Hazardous site areas	Not specified.	91m from an Urban Bird Refuge, defined as: any open space greater than 0.8ha dominated by vegetation (including vegetated landscaping, forest, meadows, grassland, water features or wetlands), or open water; green roof that exceeds 0.8ha; and 91m from Wind generators.	Windowed courtyards and open-topped atria.	Daytime: fly through area. Nighttime & inclement weather: area below 152m. Tall and glass buildings within 400m to 800m from migration route. Proximate to attractive habitat areas, fog-prone area, dense urban context, natural features, courtyards.
Hazardous building area	0-3 storeys, and 0-1 storey above green roof. Glazed corners.	0m-18m Unbroken glazed exceeds 2.2m^2 of other structures. Mirrored glass. Visible light reflectance exceeds 30%.	0m-12m (under review)	0m-23m 15m-152m inclement weather nighttime migration path. 40-50 storeys nighttime migration path. Transparent corners, mirrored glass, antennae, spires, guy-wires.
Mitigation – elevation	Collision zone: Min 85% of glazing treated. Glazed corners treated.	Min 90% treated glazing required for buildings within 91m from hazardous areas. Min 95% treated glazing required for residential building with height less than 13.7m AND exposed façade with more than 50% glazing. 100% of glazing on feature related hazard (free-standing glass standards) with unbroken segments larger than 2.2m^2 must be treated.	Min 90% treated glazing required for the first 12.2m to deter 70% or more bird collisions. Min 60% treated glazing required for other areas to deter 70% or more bird collisions.	Not specified.

BIRD FRIENDLY BEST PRACTICE REGULATIONS AND GUIDELINES: SELECTED MUNICIPAL & AGENCIES EXAMPLES (CON`T)

	City of Toronto	City of Calgary
Mitigation – materials	<u>Most effective:</u> Pattern by film, decals, Fenestration, grilles and or louvers, artwork. Multiple paned glass. <u>Others (considered less effective):</u> Angled glass panes, awnings and overhangs to provide muted reflection at the base of window, and external sunshades.	CollidEscape: one-way viewing perforated external window film. Spandrels interrupting a reflective façade. Louvers defining areas as solid. Opaque material or non-reflect glass to clearly define recessed area and courtyards.
Mitigation – specifications	Density pattern max. 10cm apart, pattern min 5mm diameter, the denser the more effective (5cm x 5cm for City buildings beginning in 2014).	Density pattern 10cm (optimal) to maximum 28cm. Angled glass panes between 20 to 40 degrees from vertical.
Mitigation – heritage buildings	Exempt from exterior lighting requirement.	Not specified.
Mitigation – site design	Ventilation grates with porosity of less than 2cm X 2cm. (Optional) Capped all ventilation	Ventilation grates with porosity of less than 2cm X 2cm.

	USGBC LEED	City of San Francisco	American Bird Conservancy	New York City Audubon
Mitigation – materials	Screens, shutters, or louvers.	Fritting, netting, permanent stencils, frosted glass, exterior screens, physical grids, UV patterns visible to birds.	<u>Most effective:</u> Recessed windows, translucent, etched, stained, frosted glass, netting, screens, grilles, shutters, exterior shades, UV pattern with strong contrast, films, decal. <u>Others:</u> Angled glass panes, awnings and overhangs. <u>Not effective:</u> Internals, shades, blinds, curtains.	Visual noise at the whole building scale. Avoid monolithic glazing. 0-10% reflectivity glass. 0-10% muted reflectivity in spectrally selective glass. Low-e glass. UV glass. Visual noise, screen/scrim/ fritting, non-reflective material, lights out, plastic films/diachroic coatings/ tints, vegetation near building.
Mitigation – specifications	Max. 5.1cm x 10.2cm (2 inches x 4 inches) of exposed untreated glass area.	Vertical treatment min 6.3mm wide at min 10.2cm spacing, or horizontal treatment at 3.1mm wide at maximum 5.1cm spacing.	Max. 5.1cm x 10.2cm (2 inches x 4 inches) of exposed untreated glass area. Apply pattern on the outside. Min 6mm wide. Angled glass panes at 20 or 40 degrees from vertical.	Angled glass panes between 20 to 40 degrees from vertical.
Mitigation – heritage buildings	Not specified.	Reversible treatment (netting, glass films, grates, and screens).	Not specified.	Not specified.
Mitigation – site design	Not specified.	Trees or tall shrubs to be within 3 feet from glazing or far away.	Place landscape away from building façade.	Maximize open space, minimize building footprint.

BIRD FRIENDLY BEST PRACTICE REGULATIONS AND GUIDELINES: SELECTED MUNICIPAL & AGENCIES EXAMPLES (CON`T)

	City of Toronto	City of Calgary
Mitigation – exterior lighting	No up-lighting. Provide shield for light fixtures. Light fixtures includes bollards, lower-scale pole fixtures along pedestrian routes. No light spill to neighbouring properties. (Optional) Rooftop lighting to be shut off between 11:00 p.m. and 5:00 a.m. (6:00 a.m. under consideration by Council) For institutional /commercial development: install an automatic device that reduces the outward spillage of internal light by 1) reducing the input power to lighting fixtures by at least 50% between the hours of 11:00 p.m. and 5:00 a.m. (6:00 a.m. under consideration by Council); OR 2) shielding all openings in the envelope with a direct line of sight to any non-emergency light fixture between the hours of 11:00 p.m. and 5:00 a.m. (6:00 a.m. under consideration by Council).	In accordance with By-law and Centre City illumination Guidelines: Floodlighting for special events and sensitive to migratory season. Minimize light transpass.
Mitigation – interior lighting	Public buildings Lights-out Policy for after work hours & weekends. (Optional) Motion sensor in linkways or zone lighting program. Individual office lighting.	Use task lighting, motion sensors, timers. Close curtains if lights are on in the evening. Schedule cleaning during daytime.
Mitigation – interior	(Optional) Locate internal greenery distance from glass relative to density pattern of adjacent window treatment. Blinds at individual work stations. Cleaning operations during daylight hours.	Locate interior landscape away from windows.

B

	USGBC LEED	City of San Francisco	American Bird Conservancy	New York City Audubon
Mitigation – exterior lighting	No direct light at 90 degrees from straight down and shut off non-essential (except safety, entrances, circulation) lights from 12 a.m.- 6 a.m. OR Light pollution Reduction Credit compliance: cap exterior lighting level and 50% interior lighting reduction from 11 p.m.- 5 a.m.	No up-lighting, no event search lighting, lighting shall be shield and minimal.	Shield and direct lighting to minimize attraction to night-migrating birds. Encourage blue and green light, discourage yellow and red light.	Reduce perimeter lighting. Shield streetlights. Minimize light transpass.
Mitigation – interior lighting	Light off between 12 a.m.- 6 a.m. minimum. OR Install auto shutoff system with max. 30 minute vacant period.	(Optional) Motion detectors and timers. See also mitigation – migratory period.	Turn off interior lighting at night or designed to minimize light escaping through windows.	Light off between 11 p.m. and sunrise. No light spill.
Mitigation – interior	Not specified.	(Optional) Move interior plants away from windows. Window coverings for nighttime use.	Not specified.	Minimize visibility of interior landscape.

BIRD FRIENDLY BEST PRACTICE REGULATIONS AND GUIDELINES: SELECTED MUNICIPAL & AGENCIES EXAMPLES (CON`T)

	City of Toronto	City of Calgary
Mitigation – migratory period	Design to minimize risk of migratory bird collisions.	Spring: Mid-March to early-June Fall: Late-Aug to early-Nov Consider festival and advertisement lighting effects during migratory seasons.
Mitigation – Monitoring program	Not specified.	Not specified.
Acknowledgment program	**2007** **Bird Friendly Development Rating System & Acknowledgment Program.** Three tiers voluntary acknowledgment program.	Not specified.
Aligned municipal requirements	**2010** **City of Toronto Public Art Policy:** Voluntary contribution of 1% of gross construction cost toward public art.	**2009** **City of Calgary Public Art Policy** 1% of capital project costs for City capital budget projects over $1 million. **Centre City illumination Guidelines.**
Agencies alliance	Toronto Hydro, Lights Out Toronto!, Canadian Wildlife Service, FLAP Canada, Building Owners and Managers Association Toronto, Cities of Chicago and New York.	Green Rating Systems such as LEED® Canada, Built Green Canada, BOMA BEST, Green Globes.
Industry alliance & public education	Lights Out Program since 1993. Poster Campaign. Consult with property managers and owners.	Not specified.

	USGBC LEED	City of San Francisco	American Bird Conservancy	New York City Audubon
Mitigation – migratory period	Not specified.	Spring: Feb 15 – May 15 Fall: Aug 15 – Nov 30 Unneeded light off from dusk till dawn.	Not specified.	Spring: Mid-Mar to early-June Fall: Late-Aug to late-Oct Unneeded light off from 11 p.m. to sunrise.
Mitigation – Monitoring program	Mandatory post-construction monitoring plan: 3 year routinely monitor. Document number of strikes, time, date, number, features that contribute to collision.	Voluntary bird-strike hotline to report bird-strikes.	Not specified.	Building management daily sweep of building perimeter and roof, document all bird death, partnership for district wide monitoring and light-out strategies, mitigation retrofits, encourage volunteer participation. Bird Safe Flight group.
Acknowledgment program	**2011 US Environmental Conservation Department Voluntary Migratory Bird Stamps Program.**	**2011 US Environmental Conservation Department Voluntary Migratory Bird Stamps Program** **2012 Design Standards for Birds-Safe Buildings.** Three tiers voluntary acknowledgment program.	**2011 US Environmental Conservation Department Voluntary Migratory Bird Stamps Program.**	**2011 US Environmental Conservation Department Voluntary Migratory Bird Stamps Program.**
Aligned municipal requirements	Not specified.	**2010 City of San Francisco Building Code Chapter 13C: Green Building and LEED requirement.**	Not specified.	Not specified.
Agencies alliance	Not specified.	Not specified.	Not specified.	Not specified.
Industry alliance & public education	Not specified.	Lights Out Program since 2008. Public education and outreach partnerships, building owner bird-safe stewardship, encourage treatment, building tenant education.	Not specified.	Lights Out Program since 2005.

APPENDIX C: MARKHAM RETROFIT PROJECTS

MARKHAM TREATMENTS: RETROFIT CASE STUDIES

Markham has shown leadership in the implementation of bird friendly measures on several public buildings including 8100 Warden Avenue, Fred Varley Art Gallery, Markham Museum, and Markham Civic Centre. It was documented that these buildings were experiencing BWCs and as a result Markham sought the advice of FLAP Canada. Through extensive consultation the buildings were retrofitted and enhanced to incorporate bird friendly treatments to avoid BWCs. For new buildings such as the Cornell Community Centre and the future South-East Community Centre in eastern Markham, bird friendly design has been incorporated into the design process. Since most of the treatments were installed in 2012 it is too soon to judge whether they are effective, but early indications are that there have been no BWCs associated with these buildings after the treatment was installed (Mesure 2013 pers. comm.).

Fred Varley Art Gallery

The Fred Varley Art Gallery in Unionville is adjacent to the Bruce Creek valley, in an area that likely provides habitat for migrating birds. The treatment, an applied film with a dot pattern called Symmetry Duo, was installed in October 2012 as a leadership initiative for bird friendly design.

Markham Civic Centre

This building was retrofitted in September 2012, as a result of concerns regarding the number of BWCs. The pattern used was Exterior 70 with custom print created for the City of Markham. Since the installation of the film, there have been no BWCs at this building. However, definitive data regarding the effectiveness of retrofitting this building has not been obtained as the amount of time since retrofitting has not been sufficient.

8100 Warden Avenue

A pattern of horizontal stripes (Symmetry) was used to retrofit the Fire and Emergency Services building at 8100 Warden Avenue in 2009 and 2010. The treatment included a large glass atrium at the entrance (top right photo) as well as several narrow, but contiguous lines of glass windows where reflections of vegetation had the potential to cause BWCs (bottom right photo). Dots were added later to complete the building treatment in 2012.

Photo by North-South Environmental Inc.

APPENDIX D: EXISTING CONDITIONS SUMMARY

Bird-Window Collisions in the Greater Toronto Area

FLAP Canada volunteers have documented approximately 45,000 BWCs in the GTA since record keeping began in 2000. These represent the results of monitoring approximately 50 buildings, mainly towers with an abundance of glass. Klem (2006) has estimated that the number of bird casualties at urban office buildings in North America is between 1 and 10 per year. Thus with approximately 950,000 buildings in Toronto, there is the potential for between 1 and 9.5 million birds to be killed in the City of Toronto per year (FLAP Canada 2013).

Two species are involved in BWCs particularly frequently in the GTA: White-throated Sparrow and Golden-crowned Kinglet, with over 5000 BWCs each since record-keeping began. **Table D-1** provides a list of the birds most frequently involved in BWCs in the GTA, with their preferred habitat.

There are several similarities among these species. With the exception of Ruby-throated Hummingbird, all are songbirds. All except Common Yellowthroat are small forest birds (Common Yellowthroat is a bird of open marsh habitat). The top 10 birds feed by gleaning: they walk along the ground or along branches, leaves or bark to glean insects and other food items. None of the top 20 species are aerial foragers. All are nocturnal

Species	Number of BWCs	Habitat	Status in Most Urban Portions of GTA
White-throated Sparrow	5212	Forest	Migrant
Golden-crowned Kinglet	5098	Forest	Migrant
Ovenbird	2150	Forest	Migrant
Ruby-crowned Kinglet	1999	Forest	Migrant
Brown Creeper	1900	Forest	Migrant
Dark-eyed Junco	1742	Forest	Migrant
Nashville Warbler	1487	Forest	Migrant
Hermit Thrush	1383	Forest	Migrant
Common Yellowthroat	1141	Marsh	Migrant, breeding
Black-capped Chickadee	1027	Forest	Migrant, resident
Ruby-throated Hummingbird	924	Forest, urban gardens	Migrant, breeding
Magnolia Warbler	822	Forest	Migrant
Black-throated Blue Warbler	576	Forest	Migrant
Swainson's Thrush	575	Forest	Migrant
Black and White Warbler	562	Forest	Migrant
- UNKNOWN	560		
Yellow-bellied Sapsucker	555	Forest	Migrant
Fox Sparrow	457	Forest, riparian areas	Migrant
American Woodcock	407	Forest	Migrant
Black-throated Green Warbler	395	Forest	Migrant

***Table D-1**: Top 20 birds most frequently involved in Bird-Window Collisions in the GTA from 2000 to 2012.*

migrants, though paradoxically they are generally killed in the daytime. It is probable that these are the most likely to be involved in BWCs because they look for food in trees and shrubs among buildings. However, another likely reason these birds are involved in BWCs is that they the most numerous species in Ontario: population estimates for the top 10 species in Ontario range from 2 million to 15 million (Cadman *et al*. 2007).

Though the numbers of aerial foragers and birds of other habitat guilds involved in BWCs are much fewer, they are still found: for example 48 Whip-poor-wills have been cataloged by FLAP Canada over the period data has been collected. This species is exclusively an aerial forager, and is also a diurnal migrant. It is also a Species at Risk in Canada and Ontario.

Among the species with the lowest BWCs (i.e. those where only 1 to 5 have been involved in collisions since 2000), there are also similarities. Very few large birds are involved in BWCs (e.g. ducks, herons, hawks, owls). There are almost no waterfowl. There are very few swallows involved in BWCs. Many of these species are diurnal migrants (they migrate during the day). It is possible that these species are not drawn to habitat in urban areas because buildings are more visible during the day.

Very few open-country birds (e.g. Eastern Meadowlark, Bobolink, Vesper Sparrow) are involved in BWCs, even though they are also ground-foragers, are small songbirds and populations for some of these species (e.g. the Bobolink population is estimated at 800,000 in Ontario) are relatively numerous. However as pointed out by Klem (2013 pers. comm.), there are very few large glass towers surrounded by open grassland habitats, so it is not known whether these species are less likely to be involved in BWCs because the habitat is not common, or if they are innately less likely to fly into glass.

Bird-Window Collisions in Markham

Eight hundred and ninety-nine birds were cataloged as BWCs in Markham from 2000 to 2012 (2% of the total in the GTA). **Table D-2** provides a listing of the top 20 species involved in BWCs in Markham, with the numbers of each species involved. There are two likely reasons for the lower number of birds involved in BWCs in Markham: there are fewer glass towers than in Toronto, and there is a much lower search effort in Markham (Mesure 2013 pers. comm.).

The bird species involved in BWCs in Markham are similar to those in the GTA as a whole: they include mainly small forest songbirds that do not usually nest in Markham (there may be very rare instances where some species nest in the largest natural areas such as the Rouge Valley). However, two of the species most often involved in BWCs in Markham, Black-capped Chickadee and Mourning Dove, are residents as well as migrants (Black-capped Chickadees may not migrate, but young of the year may wander in the fall in search of habitat so their numbers are likely inflated in the fall). It is likely that the species distribution is different because BWCs in Markham form a smaller subset of the GTA numbers.

The two resident species are likely higher up on the list in Markham (in the GTA, Mourning Dove is 46th and Black-capped Chickadee is 12th on the list) because the total numbers of birds are smaller, so there are fewer migrants. As in the GTA, there are very few BWCs involving larger birds, waterfowl, raptors, shorebirds, open-country birds and aerial foraging species.

Rank	Species	Number of BWCs	Habitat	Status in Markham
1	Nashville Warbler	97	Forest	Migrant
2	Golden-crowned Kinglet	82	Forest	Migrant
3	White-throated Sparrow	69	Forest	Migrant
4	Ruby-throated Hummingbird	55	Forest, urban gardens	Migrant, breeding
5	Ruby-crowned Kinglet	52	Forest	Migrant
6	Dark-eyed Junco	50	Forest	Migrant
7	Yellow-bellied Sapsucker	29	Forest	Migrant
8	Black-capped Chickadee	23	Forest	Migrant, resident
9	Mourning Dove	21	Variety of habitats	Migrant, resident
	Ovenbird	21	Forest	Migrant
10	Brown Creeper	19	Forest	Migrant
11	Black-throated Green Warbler	17	Forest	Migrant
	Hermit Thrush	17	Forest	Migrant
12	Blackpoll Warbler	16	Forest	Migrant
	Magnolia Warbler	16	Forest	Migrant
	Red-breasted Nuthatch	16	Forest	Migrant, resident
13	Yellow-rumped Warbler	14	Forest	Migrant
14	Blue Jay	13	Forest	Resident
15	Fox Sparrow	12	Forest, riparian areas	Migrant
16	Black-throated Blue Warbler	11	Forest	Migrant
	Pine Warbler	11	Forest	Migrant, rare breeding
	Tennessee Warbler	11	Forest	Migrant
17	Unknown	10		
	White-crowned Sparrow	10	Forest	Migrant
18	American Goldfinch	9	Forest, thicket	Migrant, resident
	Black and White Warbler	9	Forest	Migrant
	Northern Flicker	9	Forest	Migrant, breeding
	Song Sparrow	9	Forest, thicket, urban gardens	Migrant, breeding
19	Unknown Warbler	8		
	American Robin	8	Forest, urban gardens	Migrant, breeding
20	Palm Warbler	7	Forest, riparian areas	Migrant
	Scarlet Tanager	7	Forest	Migrant, rare breeding
	Wilson's Warbler	7	Riparian areas	Migrant

***Table D-2**: Top 20 bird species involved in BWCs in Markham From 2000 to 2012*

Timing of Bird-Window Collisions in Markham

There is overwhelming evidence that BWCs in Markham almost always involve migrants, rather than residents or breeding species. As noted above, most of the species involved in BWCs do not nest in the Markham area. Secondly, as shown by **Table D-3**, almost all BWCs occur during the period when birds are migrating, with most occurring during the fall in September and October, but another peak occurring during the spring migration primarily in April and May. This is consistent with information on BWCs from other jurisdictions (e.g. Chicago and New York).

Species at Risk Involved in Bird-Window Collisions

A total of 523 individuals of fourteen Species at Risk have been involved in BWCs in the GTA from 2000 to 2012, as listed below (showing numbers of BWCs/estimated numbers of adults in Ontario according to Cadman *et al*. 2007). In addition, Little Brown Bat, an endangered mammal species, has been cataloged among BWCs. The number of Species at Risk involved in collisions in Markham is low (only 6 have been found) but this is likely because of the lower search effort. Almost all bird Species at Risk in Ontario (listed as of 2013) are represented in BWCs within the GTA. In some cases, it could be said that BWCs have the potential to impact Species at Risk at the population level in Ontario; for example some with very low populations such as Yellow-breasted Chat and Acadian Flycatcher (both of which are estimated at fewer than 100 adults). All species listed in **Table D-4** could potentially collide with windows in Markham.

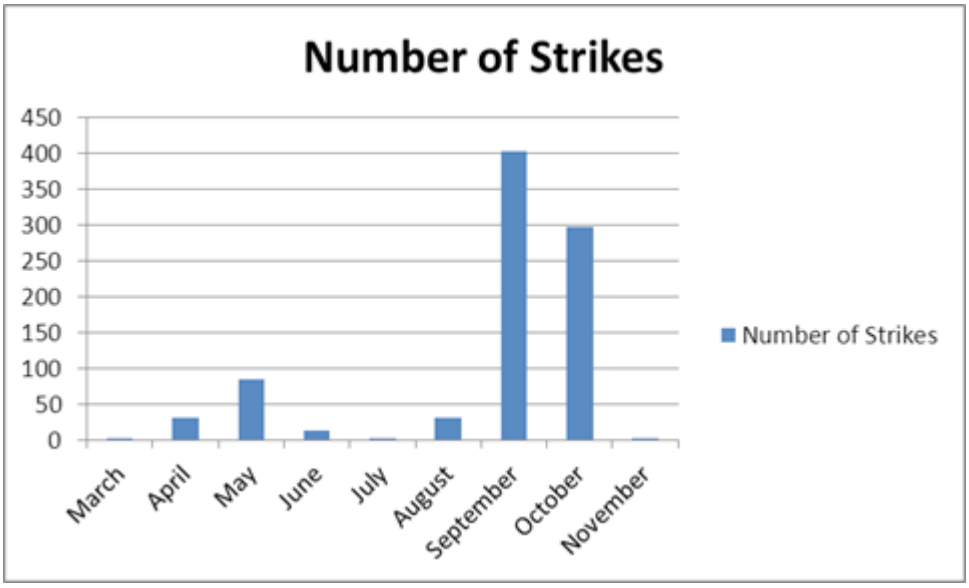

***Table D-3**: Seasonal Distribution of Bird-Window Collisions from 2000 to 2012*

Species	Federal Status	Provincial Status	Number involved in BWCs in the GTA	Number involved in BWCs in Markham	Number of Adults in Ontario (Estimate)
Wood Thrush	Threatened	none	239	5	200,000
Canada Warbler	Threatened	Special Concern	157	1	900,000
Whip-poor-will	Threatened	Threatened	48		?
Eastern Wood-pewee	Special Concern	None	37		300,000
Rusty Blackbird	Special Concern	Special Concern	10		Uncertain: 500,000 to 5 million
Acadian Flycatcher	Endangered	Endangered	9		50 to 70
Chimney Swift	Threatened	Threatened	6		8,000
Eastern Meadowlark	Threatened	Threatened	4		150,000
Peregrine Falcon	Not at Risk	Special Concern	3		78 pairs
Common Nighthawk	Special Concern	Special Concern	2		?
Louisiana Waterthrush	Special Concern	Special Concern	2		200-400
Olive-sided Flycatcher	Special Concern		2		100,000
Bobolink	Threatened	Threatened	2		800,000
Yellow-breasted Chat	Endangered	Endangered	1		80-100

Table D-4: *Species at Risk involved in BWCs in the GTA and Markham, status (in 2013) and estimates of total populations of each species (from Cadman et al. 2007). A question mark (?) indicates that the population is unknown.*

Areas with Highest BWCs in the Greater Toronto Area and Markham

Figure D-1 provides an aerial photograph showing the areas with the highest BWCs in the GTA. All of the top sites for BWCs are in Toronto. These sites include the Toronto Dominion bank towers (approximately 5000 BWCs), the buildings centred around 4025 to 4120 Yonge Street, with approximately 4500 BWCs, and Consilium Place in Scarborough (including two buildings and a glass linkway) with nearly 4000 BWCs.

While the high number of BWCs at some of these locations appear to be related to their position near a large natural area (for example the buildings on Yonge Street are in close proximity to the Don River corridor) others are not. For example the TD buildings are within a highly urban setting, and Consilium Place is also within a highly urbanized part of Scarborough, though it is at the west end of a narrow greenspace associated with a tributary of Highland Creek. Rather, the BWCs at these buildings appear to be related to the large areas of planted trees and shrubs that are reflected in the glass (Mesure 2013 pers. comm.).

The building with the highest number of collisions in Markham (8500 Warden Avenue) is included for reference; however, the number of BWCs is much lower (291) at this building than at buildings in Toronto. As noted above, the numbers of BWCs in Markham are likely less than in Toronto because of the lower search effort in Markham.

Table D-5 provides the numbers associated with the 12 sites in Markham with 10 or more BWCs. The site with the highest number is 8500 Warden Avenue, with 291 BWCs (32% of the total 899 BWCs documented in Markham). BWCs have been noted at 19 other buildings, but the numbers are much lower at these buildings: fewer than 10 collisions at each site since recording began in 2000.

The lower number of BWCs is at least partly due to the fact that information on BWCs in Markham is not nearly as extensive as in Toronto due to the much smaller number of volunteers patrolling for birds under the towers, and the lower effort spent looking under the towers. This is especially true on days when there are numerous BWCs at other sites, because volunteers are focused on rescuing as many birds as possible (Mesure 2013 pers. comm.). It is not possible to determine whether there are significantly fewer migrants in Markham. There are, at least at present, fewer glass towers.

As in the rest of the GTA, most BWCs in Markham occur during the day (Mesure 2013 pers. comm.). Forty-seven percent of collisions occur in September, and 35% occur in October, indicating that, as in the rest of the GTA, fall migrating birds are by far the most often involved in BWCs. Three percent of collisions occur in April, and 10% occur in May. Collisions during all other months make up less than 1% of the total number.

Location	Number of BWCs
8500 Warden Avenue (Hilton Suites)	291
100 Allstate Parkway	169
55 Town Centre Boulevard	58
Markham Hydro	56
Allstate Building	46
260 Town Centre Boulevard	45
675 Cochrane Drive	37
75 Tiverton Court	31
90 Allstate Parkway	26
625 Cochrane Drive	20
101 McNabb Street	14
131 McNabb Street	10

***Table D-5**: Locations of Buildings in Markham where there were 10 or more collisions from 2000 to 2012*

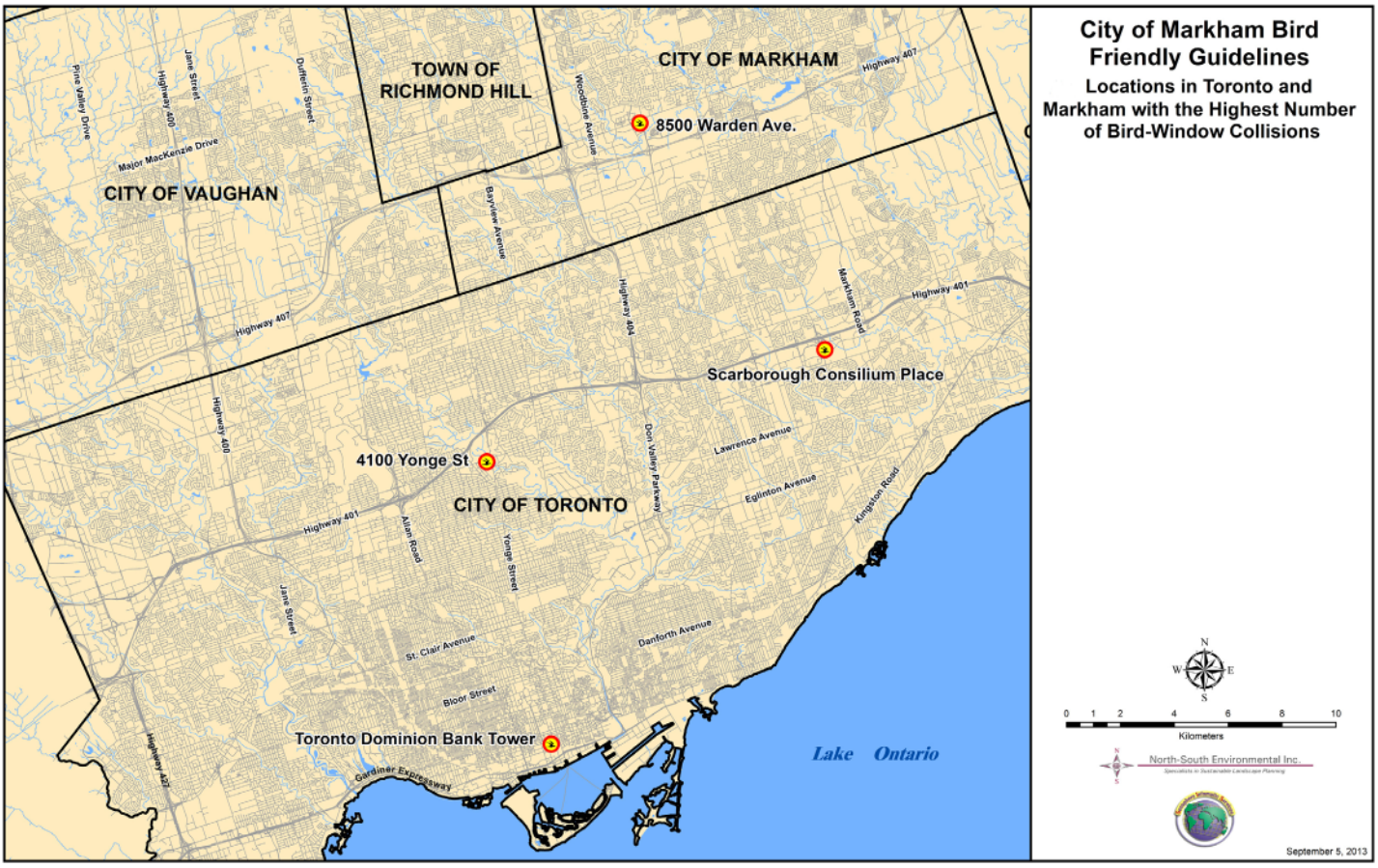

***Figure D-1**: Aerial photograph indicating highest BWCs in the GTA*
Photo by North-South Environmental Inc.

Results of Analysis to Determine whether Concentrations of Birds affects BWCs

The possibility was examined that there could be factors that lead to concentrations of birds, and could predict most likely locations for BWCs. Two factors were examined: whether there are documented areas where migrants, breeding birds or resident birds concentrate, which might be associated with higher numbers of BWCs, and whether there were obvious landscape factors (such as the presence of a natural corridor) that might be associated with large numbers of BWCs.

Areas of Bird Concentration: **Migrant Bird Concentration in Markham**

Information on areas of migrant bird concentration was sought in order to determine if BWCs were associated with areas where migrants were concentrated. Section 2 provides sight records of migrants have been recorded within the City of Markham. Records were obtained through consultation with three birders knowledgeable about Markham (Stan Long, Barrie Kent-McKay and Roy Smith), and through scanning through any available archives of three websites most frequently used by birders in southern Ontario: Ontbirds from 2013 to 1999 (the website of the Ontario Federation of Ornithologists) and the Toronto and Southern Ontario Bird Forum website from 2013 to 2006. Records were also obtained from E-bird, a website used throughout the world to record bird observations; however this website is of relatively recent origin and there were few records available. It was hoped that records could be obtained from the Toronto Ornithological Club database but Smith (2013 pers. comm.) noted that there were very few records for Markham in that database.

There were few records of migrant bird concentrations in Markham; most records involved only small numbers of birds. Long (2013 pers. comm.) explained that this is likely because birds are spread out among many small woodlots in Markham, as opposed to the situation in Toronto where birds are very concentrated along the waterfront. In addition, there are fewer birders in Markham than in Toronto.

Hotspots represent areas where a high number of BWCs occur, based on the E-bird website. Hotspots receive this designation based on birders' perceptions. The most popular birding sites in Markham are generally those where people go to see shorebirds and waterfowl, and hotspots are therefore biased toward ponds in Markham where these species are most often seen, though records indicate that songbirds are noted here as well. Since waterfowl and shorebirds are among the least numerous birds to be involved in BWCs these locations do not represent concentrations of birds that would be most susceptible to BWCs. Blue spots represent areas that are mentioned by birders without any reference to unusual numbers.

It is evident that locations of BWCs appear to be related to the locations of glass buildings rather than any known areas of migrant concentrations.

Areas of Bird Concentration: **Breeding Bird Concentrations in Markham**

The birds involved in BWCs are primarily migrants, but concentrations of breeding birds were used to suggest where concentrations of migrants might also occur, since there were so few records of migrants. Breeding bird records of birds with a Conservation Concern score of L1 to L4 (as determined by bird surveys conducted by the Toronto and Region Concentration Authority (TRCA) were plotted to determine if there were concentrations of breeding birds in the City. As illustrated in Section 2, it is evident that areas of concentration of breeding birds are not related to areas where most BWCs occur.

There are two caveats associated with the use of this data. The first is that most of the species that have the highest susceptibility to BWCs do not generally breed in the GTA: this includes for example White-throated Sparrow, Ruby-crowned Kinglet, Golden-crowned Kinglet, Ovenbird, Dark-eyed Junco and Nashville Warbler. Therefore, the classification of susceptibility of breeding species to BWCs was derived from their relative susceptibility as calculated from FLAP Canada's data for the GTA: birds with higher than 1000 BWCs were considered very highly susceptible, with 200 to 1000 BWCs were considered highly susceptible, with 20 to 200 BWCs were considered moderately susceptible and with fewer than 20 BWCs were considered to have low susceptibility.

The second caveat is that these records only include L1 to L4 species (i.e. those that have more conservative habitat requirements such as dependence on larger areas of habitat). Therefore, some of the birds that do breed in Markham, and have a high susceptibility to BWCs (for example Black-capped Chickadee) are not recorded. The birds that were recorded breeding in Markham are thus used as a surrogate to indicate where birds with different rates of BWCs were concentrated.

It appears that birds that occur in high, moderate and low numbers of BWCs breed throughout natural areas in Markham, with a few areas of concentration in larger patches of natural habitat near water bodies. Areas of breeding bird concentration are not always immediately adjacent to areas of BWC concentration. Breeding birds are found along a wide variety of natural corridors, in a variety of habitats, in large and small patches of habitat. This is likely true of migrants as well. As with migrant species, the points noted here relate to areas that have been studied by TRCA: there has been no random sampling of all natural habitat to determine relative abundance in different areas.

Areas of Bird Concentration: Resident Bird Concentrations

Resident birds are those that reside in Markham year-round. These consist of species that do not migrate, with the most common including Northern Cardinal, Black-capped Chickadee, American Crow, Blue Jay, Downy and Hairy Woodpecker, Mourning Dove and American Goldfinch.

With the exception of Black-capped Chickadee and Mourning Dove, resident species do not appear to be commonly involved in BWCs. As noted in Section 2, the birds killed in BWCs are primarily migrants.

In addition, resident birds are likely to be more widely distributed than breeding birds, as like migrants they are relatively mobile (they are not tied to breeding territories, for example) and their distribution corresponds to areas where they can find food, particularly bird feeders, during the winter. Resident birds include several that are highly susceptible to BWCs, but there are very few BWCs during the winter (fewer than 1% of total BWCs), and predicting the areas where BWCs would be most likely to occur in winter would be problematic.

Landscape Setting of Towers with High BWCs in the GTA and Markham

There are few similarities between the landscape settings of sites in the GTA with the highest numbers of BWCs. In some cases, buildings are adjacent to a large natural corridor while in other cases there is no substantial natural corridor nearby.

The site with the highest number of BWCs in Markham is 8500 Warden Avenue. As with 4025 to 4200 Yonge Street, which are located close to the Don River, the reason for the high number of BWCs may be related partly to the location of the tower (close to a tributary which may channel migrating birds from larger natural areas) but since the surrounding area is highly developed the high number of BWCs is puzzling.

The 8100 Warden Avenue building is similar to Toronto's glass towers in that it reflects the surrounding planted vegetation to a high degree. Mesure (2013 pers. comm.) and Klem (2013 pers. comm.) both stated that it is the reflectivity of the glass, which is not perceived as a barrier by birds, that is primarily responsible for BWCs. Birds are attracted to a wide variety of natural vegetation as they migrate, and even if they travel to Markham along a larger corridor, could conceivably cross the space between a natural corridor and a well-vegetated garden around a glass building in seconds.

APPENDIX E: BIRD IDENTIFICATION

The following provides a brief guide to the top 10 birds involved in BWCs in Markham, as well as the two Species at Risk involved in BWCs. Note that the photos show birds in breeding plumage only: females, many migrants and juvenile birds encountered in the fall have drab plumage that may not resemble breeding plumage.

Photo by USFWS/Creative Commons

Species: Nashville Warbler

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Photo by Jim Flynn

Species: Golden-crowned Kinglet

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Photo by Shenandoah NPS/Creative Commons

Species: White-throated Sparrow

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest, swamp

Photo by thefixer/Creative Commons

Species: Ruby-throated Hummingbird

Breeding/Migrant/Resident: Migrant, breeding

Species At Risk Status: None

Habitat: Forest, urban gardens

Photo by cheepshot/Creative Commons

Species: Ruby-crowned Kinglet

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Photo by USFWS/Creative Commons

Species: Dark-eyed Junco

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest, swamp

Photo by ptgbirdlover/Creative Commons

Species: Yellow-bellied Sapsucker

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest, swamp

Photo by USFWS/Creative Commons

Species: Black-capped Chickadee

Breeding/Migrant/Resident: Resident

Species At Risk Status: None

Habitat: Forest

Photo by Tonyotter/Creative Commons

Species: Mourning Dove

Breeding/Migrant/Resident: Resident, Migrant

Species At Risk Status: None

Habitat: Residential areas

Photo by Brian Armstrong/FLAP Canada

Species: Ovenbird

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Photo by Bruce Guenter/Creative Commons

Species: Brown Creeper

Breeding/Migrant/Resident: Migrant

Species At Risk Status: None

Habitat: Forest

Photo by Dendroica Cerulea/Creative Commons

Species: Wood Thrush

Breeding/Migrant/Resident: Migrant

Species At Risk Status: Federal: Threatened

Habitat: Forest

Photo by Jeremy Meyer/Creative Commons

Species: Canada Warbler

Breeding/Migrant/Resident: Migrant

Species At Risk Status: Federal: Threatened, Provincial: Special Concern

Habitat: Forest, swamp

Photo Credits (all Creative Commons)

Nashville Warbler Dave Menke, U.S. Fish and Wildlife Service; Brown Creeper HarmonyonPlanetEarth; Ruby-throated Hummingbird thefixer; Canada Warbler Jeremy Meyer; Wood Thrush Dendroica cerulea; Brown Creeper Bruce Guenther; Mourning Dove Larry Page; Black-capped Chickadee U.S. Fish and Wildlife Service; Yellow-bellied Sapsucker ptgbirdlover; White-throated Sparrow –Shenandoah NPS; Ruby-crowned Kinglet – ptgbirdlover/ Creative Commons. FLAP Canada photos: Ovenbird, Golden-crowned Kinglet.

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